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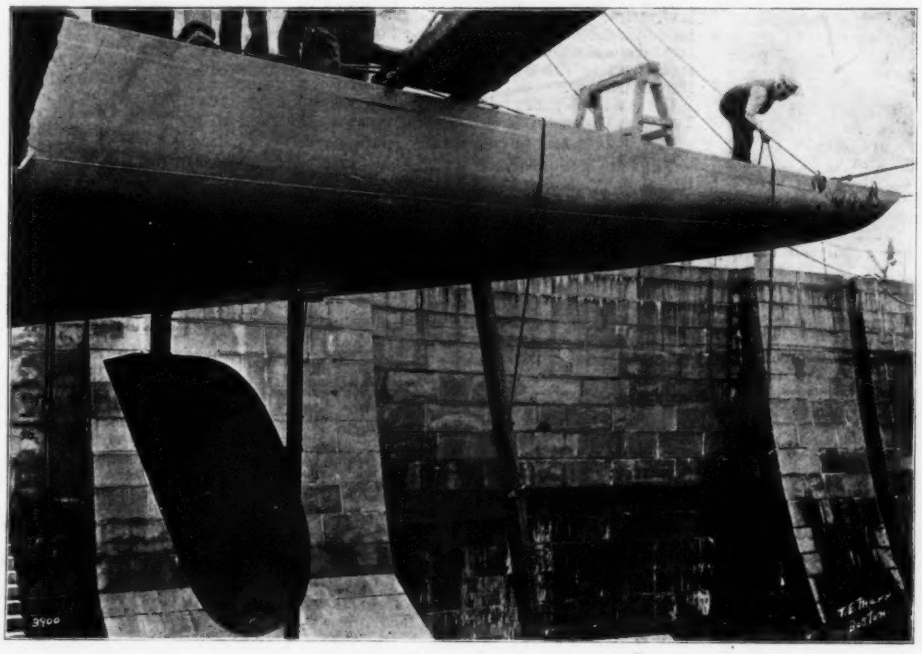
THE RACING YACHT "INDEPENDENCE."

Of the three 90-foot yachts which have been built, two in this country and one in Great Britain, for the "America" cup races of 1901, there is no question that the "Independence" shows the greatest originality in her model, that is to say, in her model considered as being that of a yacht which measures 90 feet on the waterline. To those of our readers who are familiar, even in a general way, with the racing yachts of all sizes and descriptions which have been built during the last eight or ten years, it will be evident, even on a cursory glance at the accompanying illustrations which represent the "Independence" in dry-dock at Boston, that she differs very widely from any previous vessel built either as challenger or defender of the "America" cup. She is practically a huge, flat-bottomed scow, with the ends rounded up to form the pointed bow and somewhat narrowed stern which we associate with our conceptions of a sailing vessel.

Although the scow-type, to which "Independence" unquestionably belongs, has never been seen before in a 90-footer, it is thoroughly familiar to the yachtsman whose experience is confined to the smaller classes of sailing yachts; and Mr. B. B. Crowninshield of Boston, the designer of "Independence," who is one of the most promising of our younger yacht designers, has achieved distinction in turning out some of the most successful small yachts of this type that have ever spread their racing canvas to a breeze. For their size these little craft are the fastest sailing vessels in the world; and it is a matter of record that the best of them have been known, when they were reaching in a strong wind and smooth sea, to cover as much as 11 knots in one hour. The success achieved in the smaller classes rendered it inevitable that before long some one would apply the principles of design embodied in these craft to large vessels of from 70 to 90 foot waterline measurement; and to Mr. Crowninshield belongs the credit of being the first yacht designer who has had the skill and courage to make the attempt. The "Independence" has already proved in her sailing trials that she is a remarkably fast boat, particularly on a reach, and when she meets the Herreshoff boats "Constitution" and "Columbia," as she will do early in the coming month, there will be the liveliest kind of interest taken in the result, the Herreshoff boats being distinctly of what might be called the normal type, as distinguished from the very extreme type shown in "Independence."



Photograph by T. E. Marr, Boston.

STERN OF "INDEPENDENCE," SHOWING BALANCED RUDDER.

The dimensions of the "Independence" are as follows: Length over all, 140 feet 10½ inches; length on waterline, 90 feet; overhang forward, 27 feet 5½ inches; overhang aft, 23 feet 5 inches; beam, extreme, 23 feet 11½ inches; beam at waterline, 23 feet 5 inches; draft, extreme, 20 feet; freeboard at stemhead, 6 feet 11 inches; freeboard at taffrail, 4 feet 8 inches; freeboard, least, 4 feet; deck beam at forward end of waterline, 15 feet; deck beam at after end of waterline, 18 feet 9 inches; beam at taffrail, 11 feet 8 inches; area of lateral plane, 772.6 feet; area of midship section, 117.9 feet; area of L. W. L. plane, 1,771.5 feet; wetted surface, with small rudder, 2,913.5 feet; with large rudder, 2,956 feet; displacement, 146.75 tons.

It will be seen that the amount of lead ballast carried by "Independence" is very limited for a vessel of her size, being only 75 tons as compared with 93 tons in the "Constitution" and 95 tons in "Shamrock II." At the same time the sail spread

"INDEPENDENCE" IN DRYDOCK.

Photograph by T. E. Marr, Boston.

of the Boston boat is about the same as that of her competitors, and reaches a total of 14,300 square feet. The reason for this great difference is to be found in the form of the hull; for it is one of the claimed advantages of the scow form of hull that a large amount of sail-carrying power may be secured with a relatively small amount of ballast. The great power of the hull is due to the fact that the bilges are hard, that is to say, the radius to which they are turned is small, and that the same hardness is observable, where the floor of the boat turns in to meet the keel. This insures that the center of displacement of the hull is high, and that when the boat is heeling to a breeze this center will move out rapidly to leeward and automatically preserve the stability of the yacht. This "initial stability" is further assured by the excessive length of the overhangs of the "Independence," and by the fact that the flat floor and hard bilges are carried far out into these overhangs, with the result that when the vessel is heeled she lengthens her waterline to an unprecedented extent, and thus receives added support from those portions of the hull which are only submerged as the vessel is listed by the wind. As a matter of fact, under the moderate angle of heel of 20 degrees the center of buoyancy shifts out to leeward 2.75 feet, while the same center is only 2.83 feet below the surface of the water; moreover, the waterline length at this angle of heel increases from 90 feet to 105 feet, and would increase yet more as the rail was brought down to the water.

The framing of the yacht consists of nickel-steel bulb-angles, which are spaced about 20½ inches apart, there being 79 in all in the yacht. The sheer-strake is of steel which varies from 9-32 of an inch in thickness amidship to ¼ of an inch at the bow and from ¼ to 3-16 of an inch toward the stern. From the garboard strake to the sheer strake the vessel is plated with bronze, the thickness varying from 7-32 of an inch to ¼ of an inch amidships and 3-16 of an inch forward and aft. From the garboard strake to the bottom of the keel the bronze plating is ¼ of an inch and 5-16 of an inch in thickness, while the bottom plate of the keel is a bronze casting 5-8 of an inch in thickness. The method of construction was to build up the bronze plating of the keel, fill it with pig lead, and then fill up the interstices with small shot, until 62 tons had been put in place. After the yacht was afloat it was designed that 13 tons of loose lead should also be stowed in the keel, this amount being added to or decreased according to the necessities of the case as developed during the sailing trials.

The interior of the hull is stiffened against vertical distortion by a longitudinal line of trussing which extends from the bow to the mast and from the rudder post to the stern. Additional stiffness is afforded by four longitudinal side and bilge stringers, and by a deep keel plate which is worked in intercostally between the floor plates. The total estimated displacement of the "Independence" is about 150 tons. Originally she was designed to carry 14,611 square feet of canvas, but this has been reduced by cutting down the mast five feet and the topmast by the same amount, changes which have lightened the vessel by several hundred pounds of weight at a vertical height of from 100 to 150 feet above the deck, and resulted in her showing much greater stiffness in her later sailing trials. One of our photographs shows the stern of the vessel and the balanced rudder with which she was at first equipped. This rudder has been replaced by one of the ordinary type, with which it is probable that "Independence" will enter the trial races. We are indebted for our information and photographs to B. B. Crowninshield, the designer, and Mr. T. W. Lawson, the owner of the yacht.

THE BUILDING MATERIALS OF THE FUTURE.

INTERVIEW WITH THOMAS A. EDISON.

INSURANCE ENGINEERING, having learned that Thomas A. Edison holds interesting opinions with regard to the methods and materials that will be used in the future for building purposes, sought an interview with the famous inventor and scientist. The representative of Insurance Engineering was received by Mr. Edison in his laboratory, in West Orange, N. J., and the conversation that ensued is reported *verbatim* below:

MR. EDISON'S OPINIONS.

Q. Is it your opinion that cement is to be the building material of the future? A. Yes, that and steel. That is to say, cement combined with steel.

Q. Will you cite some examples of present building materials, which, in your opinion, will be displaced by cement? A. My impression is that the time will come when every contractor will have standard forms of houses, twenty or thirty varieties. The forms will be made of wood, and a contractor using one of the standard shapes will simply go out and "pour" a house. There will probably be hundreds of designs. The contractors will put up their concrete mixer, and have their beams and forms ready. They will pour the form for the first story; complete that, then pour the second story; and so on. To do that, all they will require will be common labor—a few men and one boss. That is what I think will be done eventually. And such a house can be made very cheaply. It seems to me there will not be much use for carpenters then. There will be cabinet-makers, to be sure. Why, even the floors and stairs will be made of concrete.

Q. Will Portland cement be cheap enough for general use? A. Yes, I think so. When the price gets to be one dollar a barrel or five dollars a ton, and people know they can get it for that, there will be enormous quantities of it used.

Q. What do you recommend for use in the mixture of concrete? A. One part of cement, three parts of sand, five parts of broken stone.

Q. You think broken stone better than broken brick? A. Yes. Ashes may be used, but they are not so strong. Broken brick would do; but so long as the gravel is well crushed, it is all right.

Q. Have you seen any account of the church in Brooklyn, on the corner of Lafayette Avenue and St. James Place, built up section by section, precisely as you have described? A. No; but that is the way to do it. Houses built in that manner can be rented profitably for say seven or eight dollars a month. They will be as cheap as that. And a house can be put up and completed in a few days. The architects will have a fine time, for they can pour statuary and all sorts of ornamentation while they are completing the walls. Thus, we will have small palaces renting for about ten dollars a month. If the contractors have the proper molds, there will not be any difficulty in making the most beautiful houses wonderfully cheap.

Q. Will the use of cement modify the construction of high buildings? If so, in what way? A. All those buildings will be of steel construction, with Portland cement.

Q. Do you mean that the outside of the buildings will be of cement instead of brickwork or terra cotta, as now, and the inside structural steel work incased in cement? A. Yes; that is the idea exactly.

Q. What do you think of the article by Frank B. Abbott in the April number of Insurance Engineering, in which he recommends applying the concrete directly to the cleaned steel without the steel being painted? A. That is all right. You don't want anything on the iron. Portland cement is an alkali, and iron never rusts in the presence of an alkali.

Q. What, in your opinion, would be the effect of concrete construction on fire hazards in cities? A. Some of the fire insurance people will go out of business, so far as building risks are concerned, or write risks on the balance of what will then be obsolete houses. That, of course, is something that will come 'way along in the future. It is the element of cheapness in the houses to be constructed by this method that will prove very attractive to the masses of people.

Q. How thick do you think the walls ought to be made in the ordinary workman's house? A. The bottom course ought to be of Portland cement twelve inches up to the first story; and eight inches above the first story.

Q. And the roofs will be made of cement also? A. Yes; the whole thing—all poured cement construction.

REMARKS BY INSURANCE ENGINEERING.

Thus we are informed, on the authority of the distinguished scientist, that cement, used by itself, and cement and steel, used together, are to be the chief building material of the future. With steel-cemented construction we are measurably familiar, consequently Mr. Edison's opinion that the skyscrapers of the future are to be constructed of these materials is not as novel as his prediction regarding smaller buildings, particularly dwellings. He says that these are to be constructed of cement from top to bottom—roofs and stairs included. The prediction that in the future buildings will be "poured" is original in thought as well as in expression.

Will the demand for fire insurance cease when the time comes (if it ever does come) when all the buildings on the face of the earth are built of cement, or cement and steel? We think not. For, however much the first risk of a building may be diminished, even to the point where it disappears altogether, the risk of inflammable contents will remain, unless the time comes when all things are non-combustible. So far as walls, ceilings and roofs are concerned, the best examples of modern buildings are quite successfully constructed now, in the fireproof sense. The fires that have taken place in them show that such buildings are practically vast stoves or furnaces in which stocks of goods and other contents are quickly and completely destroyed. Furthermore, recent experience has shown that even fortresses against fire, which modern office buildings are meant to be, have weak points in windows, doors and other openings, as well as in the inflammable materials used in interior construction and decoration and in the goods and furniture composing the contents of the building. The fire insurance policy will be in demand as long as valuable property is exposed to the risk of loss by fire, and that will be a very long time indeed.

If the age of cement construction is to come, or any other kind of construction that will diminish the fire hazard, the fire underwriters will work cheerfully to hasten the ushering in of the new era. A reduction of fire perils is in the public interest, and public interest is the underwriters' interest always. Insurance can be transacted as profitably at low rates as at high rates, provided the rate is proportioned to the risk.

Mr. Edison's unqualified statement that, in his opinion, concrete should be applied directly to the cleaned steel without the steel being painted, is a strong corroboration of an opinion expressed in an article in a preceding number of Insurance Engineering. That opinion applies to present methods of construction, both as a criticism and an admonition.

PROGRESS IN PHOTOGRAPHY.*

FOR the last half century, photography, electricity and steam have been making wonderful progress in the development of the human race. Electricity has abolished time and binds the ends of the earth together. Steam is the great economizer of human effort and energy; a power that is more or less in evidence in every step of progress in civilized humanity. Photography, at first dealing with the emotional or æsthetic element in our nature, truthfully recording the beautiful, has now become one of the most practical of the arts.

Photography, a word derived from the Greek, and signifying to write by the light, is the name applied to the art of making pictures by the sun's rays. So, daguerreotypes, embrotypes, ferrotypes and paper photographs are included in the one term, photography. The whole principle of the art is based upon the chemical changes or modifications effected in certain substances by the action of light.

The early history of photography is of interest. It is somewhat strange that the very earliest experiments in that beautiful art, which was supposed to have been invented and to a certain degree perfected by Daguerre, of France, and Fox Talbot, of England, should have again been brought to light after being forgotten, and that the art which we have supposed was invented about sixty-five years ago is really a century old or more. It was invented in the latter part of the eighteenth century, became fairly successful, passed away and was forgotten, and then again evidently the same principles were discovered, the art again invented and practised and not until many years had passed was the fact learned that what we had supposed to be a new art we may call a lost art newly discovered.

The discovery of this fact was made in December, 1863, or January, 1864, by Mr. Smith, the then curator of the British Museum of Patents and Inventions. The prints and plates, as well as documentary evidence of a most conclusive kind, are in possession of the Museum.

FIRST DISCOVERY OF THE ART.

It is stated that a number of scientists known as the Lunar Society met, to communicate their researches, at the house of Matthew Boulton at Soho in the latter part of the eighteenth century. They numbered among them such men as James Watt, Josiah Wedgwood and Dr. Parr. Their experiments were principally on light, with the hope of producing reflected pictures; but the practical use of the discovery seems to have been in the hands of an artist named Eginton, who was in the employ of Boulton. It is certain that they made and sold copies of pictures by the quantity at very low rates. By the mere accident of total neglect, some of these old pictures have survived. They are copies of works by Murillo, West, Kauffman and others, and have all the appearances of photographic transfers to paper. It is particularly noted that the paper is of the old manufacture of Whatman's mills, the present proprietors stating that no such paper has been made there for the last hundred years.

The pictures are all reversed from the originals, the color does not sink into the paper, but may be wiped off the surface by a damp finger. This is not the case with photographs now made, for though on the surface of the paper, they are not erasable without sufficient violence entirely to destroy the paper, and can ordinarily be handled and rubbed without damage. Fortunately, Mr. Smith obtained a duplicate of one subject, which is so minute in its similarity as to be sufficient to prove that the process was strictly a chemical one.

Wedgwood's experiments in photography made in 1791-1793 were not published until 1802, and then under the name of Sir Humphry Davy. The article is entitled "An Account of the Method of Copying Paintings Upon Glass, and of Making Profiles by the Agency of Light Upon the Nitrate of Silver, Invented by Thomas Wedgwood, Esq., with Observations by H. Davy. (Journal of the Royal Institution, June, 1802.)"

THE REDISCOVERY.

Fox Talbot, of England, Neipce de St. Victor, and Daguerre, of France, all at the same time, about sixty-five years ago, began a series of experiments independently of and unknown to each other. Daguerre invented, or discovered, the principle of the daguerreotype, Fox Talbot a species of sun-printing on paper and Neipce de St. Victor the fact that certain substances were rendered insoluble under the sun's rays. Daguerre's process was altogether the most valuable, original and practicable; in fact, it may be doubted whether the experiments of the other two would ever have been of practical value if Daguerre's process had not been so complete. The exact date of the pension of the French government to M. Daguerre for his invention is August 10, 1830. The art was then given to the world. It was invented in 1832. There is a coincidence of dates of natural interest and inspiration to the writer, who has given his life to the art, which was conceived the year he was born.

AMERICANS EARLY IN THE FIELD.

Europe early led in the scientific development, but America in the practical application. It is difficult to decide as between Prof. Morse and Prof. John Draper to whom is due the credit for the introduction of the daguerreotypes into America. My impression is that Prof. Morse was the first to bring specimens of the silver image to America, as he was a personal acquaintance of Daguerre, but Draper was the first to make good daguerreotypes, and many of his victims who sat in the blazing sun for hours on the top of the old University building are alive, all and each of whom have "the first (absolutely the first) daguerreotypes taken in this country!"

I have a very interesting bit of history from the pen of Sidney P. Morse, in which he gives his brother, Prof. Morse, much of the credit which has been awarded to Prof. Draper. He says:

"My brother was the instrument in the hands of Providence to bring to this country that great, I may say the greatest, wonder of our age, the new art of photography. Photography, under the name of daguerreotype, it is well known, was invented by the celebrated Daguerre, a French artist, who exhibited his first collection of specimens to the members of the French Academy of Sciences in Paris early in the year 1839.

"My brother was in Paris at the same time exhibiting his telegraph to the same persons. Brother artists and brother inventors thus brought together, each was invited to examine the other's inventions, and my brother became earnest in his desire to introduce the daguerreotype into America. On his return to New York he inspired others with his own enthusiasm.

"He was then entirely destitute of pecuniary means, and after ascertaining what was wanted to enable him to gratify his wishes, we removed the central part of the roof of our six-story building, covered it with a skylight, furnished the new chamber with cameras and the other apparatus of photography, and thus completed the first tabernacle for the sun erected on the Western Hemisphere."

The structure spoken of is the old University building.

THE FIRST PORTRAITS.

In the association of the names of Profs. Morse and Draper I am reminded of the fact that the old University building had the peculiar distinction of having the first public telegram sent over wires from it, and the first photographic portrait (daguerreotype) was made within its walls. The earliest sunlight picture of a human face was the portrait of Dorothy Draper by her brother, Prof. John W. Draper, early in 1840.

* George G. Rockwood, in the New York Sun.

This portrait is in the possession of Sir William John Herschell, of Oxford, England. Of this photograph Dr. Draper wrote to Scribner's Monthly, under date of March 6, 1878, as follows:

"As to the photographic portrait from the life: it was I who took the first, and that not merely in America. At that time photographic portraiture was considered in Europe to be an impracticable thing, and when the difficulties were overcome the credit of the success was given to me."

It is said that the venerable Dr. Charles E. West, now living in Brooklyn and bearing with grace and vigor his snowy crown of 90 years, was the first man and Miss Draper the first woman to pose for a daguerreotype. Prosch, whose sons are still making lenses, made three cameras for Prof. Morse, Prof. Draper and Dr. West, and these were the first built in this country. In an interview Dr. West says:

"Samuel F. B. Morse, the inventor of the telegraph, returned from France in the winter of 1839-40. Morse had his studio on Washington Square, for he was an artist, and there we first heard of Daguerre's startling discovery. Prof. John W. Draper, a prominent authority on chemistry in those days, Morse and I, were more than interested in the subject and spent a good deal of time talking about daguerreotypes. We got George W. Prosch, an instrument maker of Nassau Street, to make us each a camera, and these three cameras were the first ever built in this country.

"In making our pictures we used iodine and bromine, vaporizing them by pouring them on heated plates. Daguerre used only iodine. The vapor settling on the plate made it very sensitive to light. A twenty-minute exposure was necessary to secure any results. For that length of time I sat before a mirror so that the reflection from the sunlight would give the necessary light to my features. When the picture was finished it showed my face with closed eyes, but the first photograph had been taken, and I was the first man, while Miss Draper was the first woman to be photographed."

Soon after the introduction in a practical form of the daguerreotype, Mead Brothers, of Albany, visited Daguerre and with Plumbe, Lawrence, the elder Gurney, Brady, Bogardus, Fredericks and others, started daguerreotype galleries as a business in various parts of the country.

At first it was feared that the beautiful image of the daguerreotype plate would fade, but this proved groundless. The introduction of the process of gilding by M. Fizeau much improved the artistic effect of the daguerreotypes and rendered them very permanent. I see many daguerreotypes and own some superb specimens which seem to be as perfect as when they were made a half century ago. I believe that this branch of the art will have a renaissance and again be practised. The important improvements in the manufacture of lenses and cameras, the knowledge gained in the construction and uses of skylights, will, I hope and believe, bring this about by shortening the time of exposure. An element much favoring such a result is the desire of many people to possess something unique in the way of a portrait of themselves or friends. One often refuses to be represented as one of a dozen!

About 1850 the collodion process appeared, and the ambrotypes and paper photographs passed the experimental stage and became a new and useful development in the photographic art. From 1839 to this date a number of men then prominent in scientific research had been searching for methods to increase the usefulness and decrease the cost of the photographic image. So, Fox Talbot, Neipce de St. Victor, M. Blanquart Evrard and M. Le Gray, followed a line of experiments in sensitized papers upon which they secured some excellent results; in fact, they compare favorably with the pictures of the present day. The paper negatives were waxed, and thus made translucent, and then printed from on silvered paper. Then followed collodion negatives, with many improvements in printing papers, and an immense impetus was given to the art. It is familiarly called the wet process, and still holds the supremacy for all copying and process work, and is in use with but slight changes in the formulas of a half century ago.

THE PIONEERS.

Soon after the introduction of the collodion process a young and active element appeared in Sarony, Kurtz, Mora, myself and others, who gave photography a strong impetus in the way both of novelty and artistic development. At this time the carte de visite was introduced, and the craze or fashion of friendly exchanges and family albums was established. The first carte de visite made in this country was of Baron Rothschild by himself, and the first lady to make an appointment for such a sitting was Mrs. August Belmont. In a few months the leading establishments were doing an excellent business and appointments for sittings were made two and three weeks in advance.

The new men who had come into the art were men of culture in art and literature; some of them were artists of experience and skill; others had been members of the press and stood high in business and social circles. The old conventionalties were cast aside, and photography received a thoroughly artistic impulse. Each worked in a degree in the line of a specialty; some to secure the great dramatic representatives and treat them with strong individuality; others exercised a fine artistic taste, and did much to the development of novelties and new improvements in the art.

PHOTO-ENGRAVING.

The use of the art in graphic illustration seemed to be a natural step forward. Experiments were made both in Europe and America toward some method of producing printing blocks from the photographic image. For quite a period the art only reproduced pictures which were already in line or stipple. The most successful results were on stone by photo-lithography. The Daily Graphic, the first to use photography exclusively, was printed from stone.

The next step was to produce zinc or copper plates which could be used with type on an ordinary printing press. Progress was very rapid. It was found that any pictorial subject that had been engraved or any picture which was in lines could be reproduced in a few hours in a relief plate and printed from as easily as the original plate. Whole books, letter presses and illustrations were entirely reproduced by photography and at a price and with a rapidity truly astonishing.

A noted English publisher learning that one of his books had been republished in America announced with great positiveness that the American edition was full of errors, believing very naturally that it would be impossible to put into type large volumes without some typographical errors. His contention was that it would require experts of almost as much skill and experience in the realms of science and literature to read the proofs accurately as to write the original articles. So he was much confused when informed that the entire volume, page for page, had been photo-engraved, with not a touch of an engraver or a type lifted.

An edition of the Encyclopædia Britannica was reproduced so excellently by this art that, were it not for the size of the reproduction, it could not be distinguished from the original. I reproduced the whole of the Oratorio of the "Elijah," music and words, of the size of the original. The advantage of doing so was not only in the cheapness of the reproduction, but also the freedom from all anxieties as concerned accuracy. Of course, no proof reading was needed.

The next step of importance in this direction is the translation of the photographic image direct to a printing block without the interposition of an artist or an engraver. That is, the events of the day are photographed and by mechanical and chemical means alone transformed in a short time to a printing block and used with ordinary types on a printing press. This is known as the half-tone process, and leaves little to be desired, so perfect are the best methods now in use by our leading magazines and newspapers. Meissembach, of Germany, was about the first in this field, followed by Ives, of Philadelphia, and Kurtz, in New York. These things are now the possibilities of the art in a practical way, and open up an immense field in all the arts.

An interesting fact concerning these photo-engraving processes is the wonderful speed with which the work is accomplished. For quite a season the translation of a photograph to a printing block was the work of hours; now it is a matter of minutes. A New York newspaper, in order to test a device which I had recently invented in this line, sent me a subject to be photographed. In sixteen minutes from the time he entered my studio the positive picture was ready for the half-tone process, which, in a rush, can easily be made in from twenty to forty minutes.

I recall the days when in a large room in the art department of Harper & Brothers there were probably forty or fifty wood engravers engaged on the illustrations intended for the various publications of that great house. We had some bright men in those days. Their province was to make drawings and designs, sometimes on the wood and at times on drawing paper. There were Charles G. Bush, E. A. Abbey, Charles Parsons and many men who through this wonderful training became famous. If I mistake not, F. O. C. Darley was an occasional contributor; but there was many a pang in the hearts of these artists when at times they found their beautiful drawings misinterpreted or mutilated in the wood cuts. To meet this difficulty I devised, sometime in the '60s, a process by which the drawing could be photographed on the wood, and it was in use for a long time with great success.

The perfected processes of photo-engraving have so taken the place of engravings on wood that I question whether there is to-day a single engraver on the regular pay-roll of the Harpers, The Century, or any of the big publishing concerns who formerly had such a large force. The beautiful wood cut is at times in evidence to cover some special requirement. The illustrations which are so often mistaken for wood cuts are retouched half-tone plates. The copper surface of the photo-engraved plate lends itself admirably to the touch of the graver. Here, too, is an outlet to the skilled engravers who otherwise would to a degree find their occupation gone.

THE DRY PLATE.

The introduction of the dry plate extended the use of photography in all possible directions, both in illustration and scientific fields. The objective point at first was not so definitely in the line of quickness in exposure of plates as to avoid the impedimenta of baths, chemicals, etc., in fact, to make a sensitive plate that would keep for a time and enable the expert to make photographs at times and in places where the old wet plate process was unavailable. So preservatives were sought and many curious articles were used, from tannin to tea.

I was drinking some superb English breakfast tea one morning when it occurred to me, more perhaps in the spirit of fun than anything else, to try a strong decoction of the fragrant beverage. I coated some plates in the usual manner, washed off the free silver, flowed them with the tea and set them up in my dark room to dry. The following day I secured some excellent views in Central Park. This for a time was the most used preservative of the fraternity, especially the amateurs.

Among the scientific amateurs, however, there was being prosecuted a series of experiments which proved eventually to be, not only a revolution, but a wonderful development in the art in every way. The bromo-gelatine (dry) plate enabled one to journey to the limits of the earth with only the camera and plates and secure instantaneous pictures or records.

Early in the '70s a series of experiments was being made in England and Germany, the most successful being by Vogel, in Germany. For many years I had made a specialty of photographing children, and only the summer before had been to Geneva, Switzerland, to see my old friend Boissonoir, who also had made the photographing of children a feature of his business, and made some improvements in the speed of wet plates. We had exchanged formulae and experiences, much to the improvement of our work, yet even three to five seconds' exposures were much too long for the nervous, active temperaments of children. So the rumors from abroad of great improvements in speed were of great interest.

I think it was in 1878 I first heard that a new dry plate had been made which worked in one-tenth the time then required for the processes in use. I quickly packed my grip and started for Berlin, where these wonderful results were being obtained. Upon reaching London I met an Englishman who had just returned from Dr. Van Monckhoven, with whom he had been studying and experimenting. I found he was thoroughly informed in all the latest improvements in what was called the gelatine emulsion process. His terms were two guineas a week. I suggested that if he would take me into his household and shut himself out from the world I would give him two guineas a day and furnish the table. As there had been no meat on the table since the preceding Easter—so I was informed by his lovely little child—it is needless to say that John Bull and Brother Jonathan were soon on the most excellent terms. In about ten days the Yankee element of that group was on the Montana speeding for home!

Now, the head of one of the largest establishments manufacturing dry plates says: "We coat on an average 100 boxes of glass a day, each box containing 100 square feet. That would make 3,000,000 square feet of glass coated by us each year for consumption by photographers in the country. This quantity is about one-fifth of the glass coated in the United States every year for photographic purposes, which would make about 15,000,000 square feet of glass coated every year. This glass would weigh about 7,000 tons."

This estimate is confirmed by other manufacturers, and is given at a time of year when the amateur is still hibernating. The amount of films for the hand cameras usually called kodaks is also incredible. Some time ago the average output in one establishment was equal to a band forty inches wide and two miles long every day.

Following soon after the introduction of the dry plate came an effort to do away with the necessity of carrying the heavy glass plates. The first effort was made in the use of paper instead of glass which was coated with the sensitive film. After exposure and development, the paper negative was rendered translucent by castor oil and excellent results were obtained. Then followed the celluloid films. It has recently been decided by the courts that the Rev. Dr. Goodwin, of Newark, lately deceased, was the inventor of this agent which has revolutionized the work of both the professional and amateur.

THE SUPPLY OF PAPER.

As necessity is the mother of invention, so, often, it is the parent of production. It was early discovered that good photographs could be made only on papers which were, so to speak, chemically pure. In a little obscure town in Germany named Malmedy there was made a paper which seemed to meet all the requirements of absolute purity, whiteness and strength under manipulations of the printing processes, and for half a century this town and Rives, in France, have practically supplied the world. The German "Steinbach" is considered the strongest and best. The statement has been made that the absolute purity of the water was the chief factor in the result. Many attempts have been made in our own country, but not until the last few years have we been able to produce a paper comparable with that made in Germany. I believe all the leading manufacturers still adhere to the foreign make. The defects in the American made paper were minute metallic spots, the presence of organic substances, imparting a tinge of color, and want of tenacity and strength.

THE FLASHLIGHT.

The experiments of Dr. H. G. Piffard were a great factor in the development of the flashlight. The flashlight, by which instantaneous pictures can be taken at night, is one of the most interesting devices of latter-day photography. The doctor for some years had been interested in microscopy and photography, using both in the illustration of his professional work. The inconvenience of securing the services of professional photographers, and having his patients removed to public establishments, led him to operate for himself and to become expert in the use of the camera. The proper lighting of subjects in an ordinary dwelling or office was not always possible, so for a long time he experimented to produce an artificial light that would answer his purpose, and at last produced a very simple combination, which accomplished all he could desire. It also opened up possibilities to the professional and amateur photographer that may well be termed marvelous.

The knowledge of the possibility of such photographs was not new, as for years previously Vogel and Gaedicke had made them abroad, but by means that were not altogether safe, as the chemicals employed were liable to explode unexpectedly. Dr. Piffard simplified the proceeding and made use of means that are not only safe, but can be readily obtained.

I think it is about twenty-five years ago that I gave instructions to a photographer to make a series of negatives by magnesium light in the Catacombs of Rome to be used in the illustration of a book then in preparation by the late Rev. Dr. Robert S. Howland. I had the satisfaction of seeing excellent prints made from the plates. Magnesium is now in constant use in photographing at night banquets, wedding parties, plays, etc.

(To be continued.)

Action of Alcohol of 95 Deg. on Metals.—The alcohol used by Malméjac for testing this behavior was pure and did not leave any residue upon evaporation; 250 c. cm. of this alcohol each were filled in corked-up white-glass flasks, containing 30 grammes of one of the following metals: Copper, tin, iron, lead, zinc and sheet zinc. These samples were kept for six months and shaken all at once from time to time. Thereupon there was observed on the bottom of the bottles containing tin, zinc, lead or sheet zinc a white precipitate which was mixed with the respective metals. The bottle with the iron contained a deposit of rust. Therefore, if alcohol of 95 deg. is kept in metallic vessels, the fact has to be taken into account that some of the metal is dissolved.—Jour. Pharm. Chim., 1901, 6th Ser., 13, 169.

THE STEAMSHIPS "PORT ROYAL" AND "PORT ANTONIO."

WE illustrate the triple expansion engines of two new steamers which represent a very important departure in British trade. This machinery may be regarded as the embodiment of all the improvements effected of late years which have proved themselves to be worth retaining. The boilers are fitted on Howden's system, and nothing has been left undone to secure general excellence, says The Engineer.

The steamers are the "Port Royal" and the "Port Antonio." They have been specially constructed to be worked under a government subsidy for the development of our trade with the West Indies. This enterprise, which originated, we believe, with Mr. Chamberlain, is destined in the first place to put new life into the present stagnant condition of the agriculture and trade of Jamaica, which has suffered so severely from the ruin of its sugar cultivation, caused by the continental bounty system. The immediate object is to establish a new industry in the islands by promoting the fruit trade, in which enormous possibilities exist. It is already very large between the West Indian Islands and the United States. Hitherto the distance and deficient means of transport across the Atlantic have been prohibitory to its encouragement with this country; and seeing what enormous strides have been of late years made in the fruit trade from the Mediterranean ports and Spain, the American and Canadian ports, and especially the Canary Islands, as well as from distant Australia and New Zealand, it was self-evident that all that was required was an adequate service by a line of fast steamers, especially built and fitted with refrigerating appliances and storage, to enable the untold amount of available fruit of the West Indies to be delivered in England in a fit state for the market.

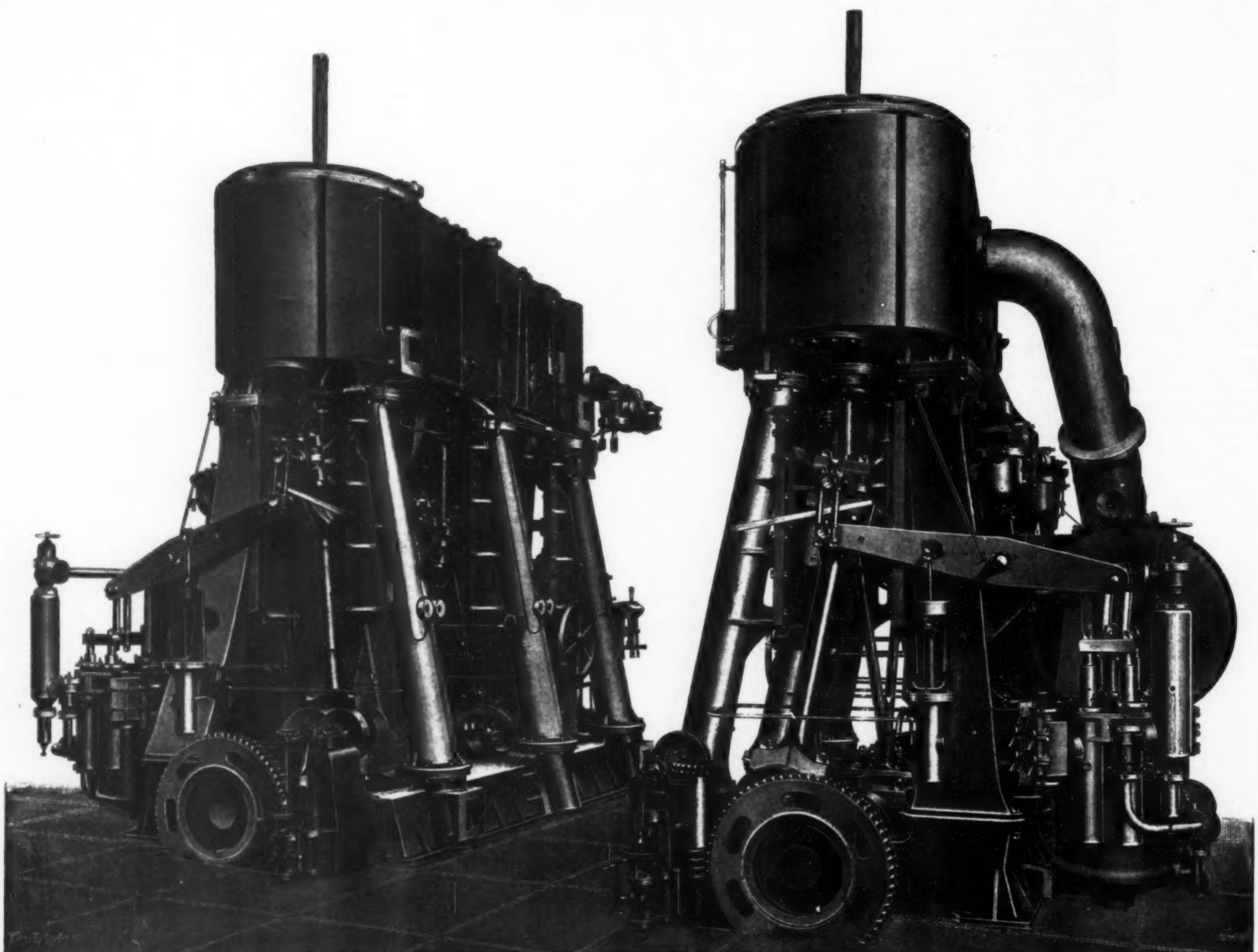
Mr. Chamberlain therefore applied to Parliament for a grant in aid, or subsidy, to start a new line of mail and fruit steamers from Jamaica to Bristol, which was granted last session, Parliament voting a subsidy of £40,000 per annum toward the working of this new line. His next step was to find a firm of steamship owners ready and competent to undertake the equipment and running of the line, and selected Elder, Dempster & Co., whose headquarters are in Liverpool, and under whose chairman and managing director, Mr. A. L. Jones, the banana trade from the Canary Islands has been made so wonderfully successful that nearly the whole of the enormous supply of that fruit, which of late years has been so plentiful in England, has been almost entirely in his hands. He therefore entered into a contract with the Colonial Office to build and fit out a line of steamers to provide a fortnightly sailing from Jamaica, and fixed Bristol as the port of arrival in this country. In return for the important subsidy of £40,000 per annum Mr. Jones undertook not only to provide the mail steamers necessary to make the voyage in twelve days, but to provide skilled agents to improve fruit cultivation in Jamaica; also to purchase from the growers of the fruit in Jamaica a minimum of 20,000 bunches of bananas to be shipped every fortnight. The next step was to provide the necessary steamers, and a contract for the building of these was at once put into the hands of Sir Raylton Dixon & Co., Limited, of Middlesbrough, who has already built a large fleet of steamers for Messrs. Elder, Dempster & Co., and, moreover, had had large and very successful experience in the building and fitting out of steamers with refrigerated holds for the fruit trade between the West Indian Islands and the United States, etc. Accordingly, plans were promptly prepared for two first-class twin-screw steamers, capable of attaining a speed of 15 knots, with accommodation for carrying His Majesty's mails, 100 first-class, and 50 second-class passengers, with holds specially lined and insulated for carrying fruit in large, well ventilated compartments in the 'tween decks, provided with Hall's refrigerating machinery, and means for maintaining a uniform temperature. The vessels so designed are of the following dimensions: 382 ft. long, 46½ ft. beam, and 32 ft. 7½ in. molded depth. They have awning deck, with forecastle, and long deck-houses amidships, providing a promenade deck, on which are the captain's cabin, smoke room, etc. The decks and outside fittings are all of teak, and the passenger accommodation is luxurious. The first-class dining saloon is arranged at the forward end of the large deck-house, the walls are of polished marble, and the woodwork of dark mahogany upholstered in rich tapestries, and lighted by electricity. There is also on deck a fine smoking room and a library or ladies' lounge. Ports in the ship's sides are provided for rapidly loading and discharging the ripe fruit in crates, and the hatchways are provided with steam winches and discharging gear of the latest and most approved type.

The machinery we illustrate is capable of developing 4,800 to 5,000 horse power at sea, and has been specially designed for continuous hard steaming. It will be observed that the twin-screw engines are separate and self-contained, and that they are very massive in design. The cylinders of each set are 24 in., 38 in., and 64 in. diameter, by 45 in. stroke, and the engines run at about 90 revolutions. All the bearing surfaces are exceptionally large, the shafting throughout is of steel, the straight shafting being of Firth's hydraulic pressed steel. The tunnel shafting is 12¼ in. diameter—that is, 20 per cent over Lloyd's requirements. The thrust shaft is 12¾ in. diameter; the thrust blocks are of the horseshoe type; the crank shafts are 12¾ in. diameter, 22 per cent above Lloyd's requirements. The webs are of forged iron, not steel; the crank pins are 13 in. diameter and 15 in. long; the cranks are set at equal angles, high-pressure leading. The connecting rods are of iron; the piston rods, 6½ in. diameter, of forged steel, and packed with "Cleveland" metallic packing. The propellers have manganese bronze blades. It will be observed that the condensers are separate circular chambers, supported on the back columns throughout; the water is circulated by centrifugal pumps, and the air pumps are on Edwards' patent principle. The feed pumps on the main engines discharge through a Hocking's patent filter to a Weir's feed-heater, the boilers being fed by a pair of Weir's pumps. The engines are, of course, fitted with steam reversing gear, steam turning gear, and all other modern appliances, including Geddes' patent self-acting drain traps to the receivers.

The four main boilers are each 16 ft. diameter by 12 ft. long, having three large Morrison's furnaces, the total heating surface being 12,000 square feet; the working pressure is 180 lbs. It will be observed that the boiler shells are each made of three plates, the builders having special appliances enabling them to make this arrangement, which is very unusual for boilers of this size. The boilers are placed in the vessel in pairs, back to back, so that there are two stokeholds; air is supplied to the furnaces by one double inlet fan, 102 in. in diameter, and driven direct by two engines having cylinders 8 in. diameter. The funnel is 10 ft. in diameter. The boiler tubes are of wrought iron, 2½ in. diameter outside, 8 ft. 2 in. long between the tubes, No. 8 w. g. thick; the minimum water space between the tube plates is 1¼ in. The boilers were hydraulically tested to 360 lbs. per square inch.

The pistons are strong box castings, well ribbed and carefully turned and fitted. The junk rings are very deep, and the junk ring bolts of large diameter, fitted into deep brass nuts which are screwed into the pistons and secured by a stop pin. The bolts have large, square heads secured by copper washers. The high pressure and intermediate pistons are each fitted with three cast-iron "Ramsbottom" rings. The junk rings and block rings are in one piece, with the packing rings sprung into grooves, so that all can be lifted out together. The low pressure pistons are fitted with McLaine's rings and springs.

The high pressure cylinders are fitted with piston valves, fitted with solid adjustable packing rings, very carefully made and fitted, and have extra wide bearing surfaces. The steam is taken in the center of the valve. The top valves are about ½ inch larger in diameter than the lower valves. The intermediate and low pressure cylinders have ordinary double-ported slide valves, with springs at the back to keep them up to the face; the valves are secured to the spindles by



TRIPLE-EXPANSION ENGINES, STEAMSHIPS "PORT ROYAL" AND "PORT ANTONIO."

large square washers at the bottom, and iron washers and double brass nuts with a split pin at the top. Balance pistons are fitted to the top of the intermediate and low pressure valve rods.

The whole of the work will maintain the very high reputations of Richardsons, Westgarth & Co., Limited. The "Port Royal" is now on her second voyage, and the "Port Antonio," now being fitted out, will be ready for sea in about two months.

A NEW AUTOMATIC SCREW MACHINE.

OUR illustration represents an automatic screw machine built by the Automatic Machine Company, of Greenfield, Mass., on a radically new principle. The machine weighs 1,500 pounds and has a chuck capacity from ½ inch down. The legs are cast in pairs, one pair being bolted to the oil-bed, the other hung on a rocking shaft so that the machine can be bolted firmly to the floor without straining any of its parts.

Only a single belt is used to drive the moving parts. Hence, if the lacing should break, the feed cannot run away, and hence the disastrous results which are of only too frequent occurrence when the feed is driven independently of the spindle are obviated.

By reason of this novel belting, moreover, it is possible to place the machine on the floor at a slight angle with the main driving-shaft, and still enable the belt to draw with a constant and true tension. It is therefore possible to get the machines closely together in a line down the length of the shop.

In place of the old flat-faced drum, requiring the use of straps bolted to its face (with the endless trouble of setting these straps by guess and of drilling and tapping holes), the designers of the machine have adopted the method of fastening the cams to the drums by "T" bolts. A machine can hence be changed to produce a different kind of work in a very few minutes, and adjusted to a certainty. These drums are covered with substantial casings, which can be readily removed for adjustment and replaced as quickly. Those who have been obliged to use the old strap will appreciate the merits of this method of camming automatic machinery.

The entire feed mechanism of the machine is thrown in and out by the use of a clutch on a hand-wheel placed in front of the machine. By the use of this clutch the operator can stop or start the feed while the machine is in motion. By releasing the clutch the feed mechanism can be moved forward or backward by a hand-wheel. The device is very serviceable in setting the machine for different kinds of work.

This machine is also provided with a contrivance by which the feed can be accelerated in order to bring the different tools into position without loss of time.

The automatic wire feed is controlled by hand-levers conveniently placed within easy reach. The spindle is provided with friction-clutches which are shifted by dogs on the feed-shaft. This device is so constructed as to be engaged or disengaged without any concussion, and still be positive in its action.

The turret on the machine is provided with holes for four tools, and is constructed so as to be removed entirely if so desired and replaced in exact position simply by releasing one screw. It is provided with a positive stop and with a device by which it can be turned completely around if necessary without being carried forward and backward for each hole. In this manner two tools can be used and no time lost in passing by the vacant places.

Instead of being placed on horizontal slides, the cross-slides are placed vertically. Each slide is independent of the other and is provided with a fine adjustment. Hence, no chips or dirt can fall between the slides. The machine, moreover, can be built very compactly and the turret-slide made short.

The machine is provided with a device by which the work is taken from the bar when completed, carried against a slotting saw when required and deposited in a special receptacle. Thereby the annoyance and loss of time caused by the finished product's mingling with the chips and oil is avoided.

NEW BURNER FOR GASOLINE MOTORS.

THE new burner illustrated herewith, and called by its inventor an "auto-incandescent," is based upon the property possessed by platinum sponge of absorbing gases upon becoming incandescent—a phenomenon known by the name of occlusion. The platinum tube, *D*, secured to the motor, enters a second platinum tube forming part of the burner. In the annular space is placed the platinum sponge. A small special reservoir contains gasoline under pressure. This, through a needle valve, is sent to the burner, *A*, where it becomes vaporized in a spiral tube, and is then led to the injector, *O*. There is produced a draught of air which mixes with the gasoline vapor, and this carbureted air is projected against the platinum sponge. The resulting incandescence is communicated to the platinum tube, and explosions are thereby produced in the motor. By modifying the quantity of gasoline

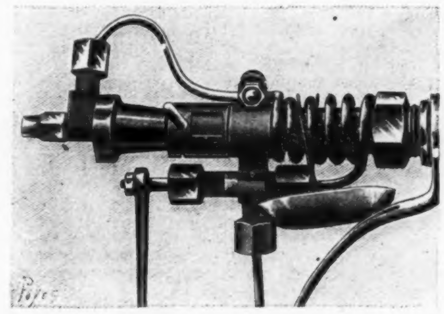


FIG. 1.—GENERAL VIEW OF THE AUTO-INCANDESCENT BURNER.

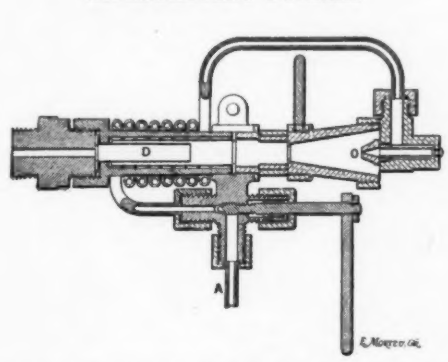


FIG. 2.—SECTION OF THE APPARATUS.

sent to the burner, by means of the valve, the incandescence of the platinum tube is varied, and the effects of advancing or retarding the sparking are produced.

[Continued from SUPPLEMENT, No. 1329, page 21310.]

PROTECTION OF FERRIC STRUCTURES.*

By M. P. WOOD, New York, Member of the Society.

GRAPHITE.

30. GRAPHITE in the many varieties of its foliated flake or amorphous forms, is found in all parts of the world and is of various degrees of purity; ranging in the foliated form, from 60 to 99 per cent of carbon. Its specific gravity ranges from 2.255 to 2.768. The Ceylon, Cumberland, Indian, and American varieties are remarkably pure, and are used principally for pencils, crucibles, lubricants, stove polish, and to tone up the Siberian, German, and other poorer varieties for the many purposes of the day, which have developed a branch of manufacture second to none in energy, skill, chemical knowledge, and trade requirements.

In this article we are dealing with graphite as a pigment, and however suitable a foliated graphite may be for a pencil, crucible, or lubricant, its use as a pigment, for the reasons mentioned before, is not as satisfactory as the amorphous variety which, less rich in carbon, contains other substances non-corrosive, non-absorbent of moisture and gases, either individually or collectively as a granulated natural compound. That this point may be duly considered, when a pigment is to be selected for ferric structures, we give the following analyses of amorphous graphite from three widely separated mines:

	Siberian and German Mines.	Lake Superior Mines, U. S. A. Detroit Graphite Mfg Co.
Carbon	33.20 to 36.06	28.39 to 33.48
Silica as SiO_2	43.20 " 37.70	46.97 " 37.54
Iron soluble as Fe_2O_3 / " insoluble as Fe_2O_3	3.05 " 4.02	4.22 " 14.25
Alumina as Al_2O_4	15.42 " 17.80	16.90 " 12.35
Calcium as Ca_2O_4 / Magnesia as MgO	1.06 " 1.20	0.99 " 1.02
Carbon dioxide, combined water, sodium compounds, volatile matters, iron pyrites and loss	4.09 " 3.22	2.53 " 1.36
	100.00 to 100.00	100.00 to 100.00

These minerals grind and bolt in a granular and approximately cubical form, are not repellent of the oil or vehicle, are nearly as unoxidizable from moisture and atmospheric influences, combustion gases, etc., as pure carbon; are of an agreeable color of themselves as pigments, work well in combination with other colors, flow well under the brush and cover as much surface as any other good paint; do not separate from the oil in the paint pot or barrel in storage, are prepared ready for use, and cost less per gallon, and will last longer when properly applied to a ferric structure than any pure flake graphite pigment which was the base of Prof. Spennrath's experiments. They are practically indestructible by any heat less than that which would char the oil (500 degrees Fahr.).

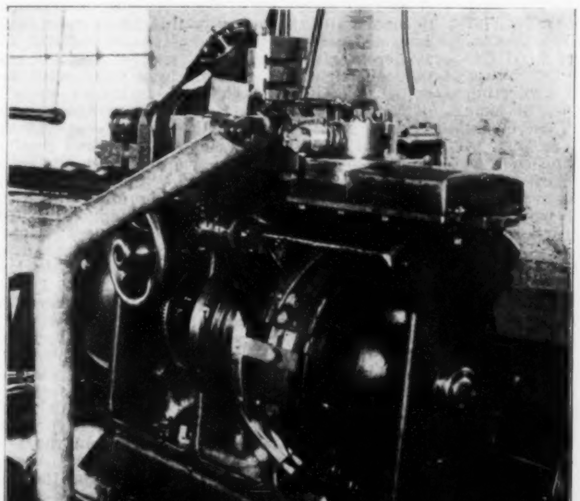
31.* Boiler tubes coated with the Superior Graphite brand of paint having been exposed to internal firing and hot water action under constant working pressures of eighty or more pounds per square inch for two years, have kept their coatings uninjured and as fresh as when first applied. Pieces of iron coated with this brand of paint have been dipped in muriatic, sulphuric, and oxalic acids, and then allowed to dry with the acid on them for nineteen days without showing a trace of any damage to the paint. Other protective oil paints subjected to the same tests were utterly destroyed in twenty-four hours. Superior Graphite paints have been immersed in strong solutions of sal-soda and ammonia for nineteen days, and in coal oil for several weeks, without showing injury. Tested in boiling alcohol, boiling beer, boiling brine, boiling sugar and water, cold soft soap for twenty-four hours, they remained uninjured, while other protective paint coatings exposed to the same tests were destroyed in from fifteen minutes to one hour. These results were produced by specially prepared samples for the several special requirements to which the coating was to be subjected in service, but the pigment base of the paint was in all cases the ordinary stock of commercial Superior Graphite paint sold in the open market by thousands of barrels yearly.

32. While tests of special paints are not regarded by many engineers as indicative of their value to resist the ordinary conditions of a coating exposed to weather, they do show that paints which can withstand these severe tests are certain to give more satisfactory results in general use on any ferric structure than the many competitive and cheaper coatings whose low price, and not their protective results, are their principal recommendation. They also show that if the conditions are known, to which a coating is to be subjected, it can be generally furnished to meet them successfully. That the strictly commercial brands of the Superior Graphite paints appear to be as thoroughly reliable protective coatings for ferric structures exposed to weather under the various conditions to which such bodies are generally subjected, as are the special brands of paints above mentioned, is evident from the following examples selected from scores of instances of their application:

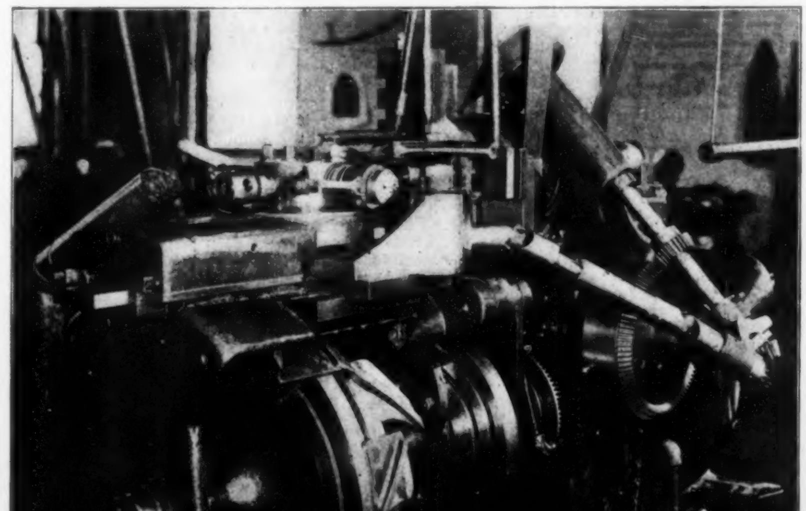
33. The Union Station railway viaduct over the Michigan Central Railroad at Detroit, Mich., erected in 1891-2, was painted with red lead, which utterly failed within two years, owing to the smoke and steam from the locomotives in constant service beneath it. About one-half of the entire structure, comprising the most exposed and badly injured portions, was repainted in 1894 with *one coat* of Superior Graphite paint, and is, at the present date, in as perfect condition as when repainted, and will evidently remain so for many years. The failure of the red lead coat-

* Presented at the Milwaukee meeting (May, 1901) of the American Society of Mechanical Engineers.

* Trans. A. S. M. E., 1894, vol. xv., paper No. 598, pages 1072, 1073; also 1895, vol. xvi., paper No. 637, page 700.



FRONT VIEW OF AUTOMATIC SCREW MACHINE.



REAR VIEW OF AUTOMATIC SCREW MACHINE.

ing could have been foreseen, had the engineer in charge known the fact that an oxide of lead coating exposed to gaseous acid or hydric sulphide (always present in the gases of combustion) *by the inexorable laws of chemistry* changes the oxide of lead to a sulphide of lead, whose volume is 33 per cent greater than the oxide from which it was formed, this change taking place while the oxide is embedded in the dried menstruum. No wonder that the red lead coating failed here, as it will in all other locations in the presence of hydric sulphide, hot or cold.

34. The structural and covering steel work of blast furnaces, the rolling mills and other workshops connected with manufacturing steel plants, are particularly exposed to the attack of this gaseous acid, and where the protective coatings have been red lead, it has always failed after a brief existence, and always will.

The engineer of a prominent Western steel plant, after a thorough test of ten different paints, extending over three years, abandoned the use of red lead, and all other competitive paints, selecting the Superior Graphite paints for the blast furnace and all other buildings of his company, also for repainting the old ones.

35. An important railway bridge over the Monongahela River at Pittsburg is in a particularly exposed position, subjected constantly to an atmosphere heavily charged with moisture almost amounting to a perpetual fog, charged with the sulphurous fumes from passing steamboats, and the manufactories in the city. It was painted in 1896 with Superior Graphite paint, which is to-day in perfect condition, and will not need repainting in many years.

36. The double deck bridge of the Chicago, Rock Island and Pacific Railroad, over the Mississippi River at Rock Island (the largest bridge over that river), was coated in 1897 with Superior Graphite or L. S. G. brand of commercial paint, selected by the railway and the United States Government engineers in charge of the work after an extended examination and test of many paints in competition. The present coating of this bridge is perfect in all respects, though is an exposed situation, and subjected to the unusual conditions of a railway, animal, team, and footway service.

37. The structural steel work of the United States Government Printing Office at Washington, D. C., the Waldorf-Astoria Hotel, and the Metropolitan Life Insurance Building in New York city, all ranking among the largest, best designed, and constructed buildings in the world, are all painted with Superior Graphite paints, selected from many competitive paints, after long and exhaustive tests of the same by the architects and engineers in charge of their construction. The same can be said of scores of other large and first-class modern steel structures, in New York, Boston, Philadelphia, Chicago, and other cities. The Superior Graphite paints have been selected as coatings in almost every case after competitive tests with other ferric coatings.

38. These favorable results, following the use of this brand of graphite paints, have been taken almost at random from hundreds of applications to all kinds of structures, large and small, and under all possible conditions of exposure. They cannot be deemed accidental results, but must rest upon the superior quality of the amorphous graphite pigment, the well selected and carefully prepared menstruum, the thorough methods of manufacture, all combined to produce a homogeneous reliable product, which is not due to any haphazard combination of fortuitous events.

39. Parties in interest as users of large quantities of paints ask why the Lake Superior amorphous graphite furnishes a pigment superior to other brands richer in carbon either as an ore or combined with free silica. The qualities of an artificially combined carbon and silica pigment are given elsewhere in this paper. With a natural graphite ore, the larger the percentage of graphite carbon, the lower is the percentage of silica combined with it, the other combined substances, about 20 to 24 per cent (see analyses), remaining approximately the same. If the combined silica be wholly replaced (or nearly so) by the carbon the ore becomes greasy to the touch, does not grind well, is repellent to the menstruum, does not spread well as a paint, and when the menstruum is weakened or affected by causes due to elemental or other effects, and the pigment atom is exposed, its bond with the menstruum and to the surface on which it lies or is in juxtaposition, is weak by reason of its repellent nature, and it is soon washed out, and a porous coating results which hastens the decay of the whole coating. Experiments show that graphite ores containing 60 or more per cent of graphite carbon *are not* any more, if as durable pigments, when exposed to either chemical or natural decay, as those containing lower amounts of carbon. A graphite or other mineral atom will bond better to the menstruum, and to the surface over which it is spread, when the percentage of the metal or substance that forms the base of the mineral is low.

ASPHALTUM COATINGS.

40. The so-called asphaltum paints in general have thus far proved to be quite as ineffective as protective coatings as any of the iron oxide or miscellaneous compound paints. Their name is a misnomer, as few, if any, contain 5 per cent of asphaltum, and even that amount is seldom treated to free it from the vegetable matter and acids with which it is associated in its natural state, and, as a rule, the substances incorporated with it as pigments are quite as carelessly chosen, and uncertain in composition as the asphaltum itself, which is simply the residual from evaporated petroleum, and contains in its natural state often as high as 10 per cent of sulphur. Benzine and bisulphide of carbon (made by passing the vapor of burning sulphur over burning charcoal) are generally employed as solvents of the asphaltum in the preparation of the menstruum, and whatever pigments are incorporated with it, they are more or less affected chemically by the bisulphide ingredient. They are in no respect a synthetical mixture, either in the pigment or paint, but are mechanical haphazard compounds drying by evaporation instead of by resinification. Its name is a catchy one to conjure with, and to sell the product, and its use should be confined to the many minor ferric constructions of the day, but not allowed on the more important structures, whose condition should be always above suspicion of corrosion. Its low price is a strong element in its favor with purchasing agents and indifferent bridge painters, where quantity rather than quality governs. A moderate price in a bridge paint usually denotes a moderate or no result in a protective sense.

41. Bitumen, asphaltum, and other varnishes, *not paints*, have not received the attention from engineers and other persons responsible for the care and protection of our ferric structures that their merits deserve. This is probably owing to their high cost. The skill required in their preparation debars the average paint compounder from attempting their manufacture, and more care is required to apply them than the cheap painter will give.

42. A notable instance of their efficiency when well made is afforded in the case of the steamer "Glenarm," used in the coasting trade between Scotland and England, that was wrecked in 1895. (For full report see Engineering, July 13, 1896, pp. 157, 158; also Transactions American Society Mechanical Engineers, vol. xviii., 1896, paper No. 713, pp. 251-289.) This ship, carrying 650 tons of burnt iron ore or residuum from the manufacture of vitriol, was beached to prevent total loss. She was submerged to her deck for *only six days*, when she was pumped out and raised. All of the bright iron surfaces of her engines and the inside surface of the steam cylinders and chests, donkey pumps, boilers, etc., were corroded and softened from 1-32 to ⅛ of an inch, and required to be remachined in all their parts. All the copper pipes were affected, many were renewed. The composition metal in the valves, packing rings, etc., appeared as though the zinc in the metal had been sucked out. Every 100 tons of the burnt ore carried corrosive agents which have dissolved at saturation, thirty-two hundredweight (3,584 pounds) of iron, or for the whole cargo 21,504 pounds. How much iron in the ship and machinery was actually dissolved in the short period of her immersion is unknown, but it must have been considerable from the effects upon her machinery as above stated. What would have been the effect had the immersion been 30 or 60 days can only be conjectured from the fact that the bolts and nuts, hammers, spanners, firing tools, and all small and loose iron parts were wasted away to a semblance and required renewal. The shaft journals, crank pins, and all exposed parts between the boxes and housings were badly corroded, and requiring remachining. The machinery parts of the vessel other than its bright or moving parts were painted with *red lead and boiled oil;* the walls of the engine and fireroom and passages were painted with *white lead*, and *both were unaffected by the corrosive bath*. All parts of the journals which were in actual contact with other metal, but with a film of heavy lubricating oil between them, were also uninjured. The framework, inside skin of the vessel, coal bunkers and cargo bulkheads, etc., were uninjured, though exposed to the full strength of the solution from the corrosive cargo, as the sea water here had no change from the tides as in other parts of the vessel. These parts were coated with James Ritchie & Sons', Limited (Belfast), anti-corrosive bitumen varnish (*not paint*), manufactured from pure bitumen freed from organic acids, etc. This was an extraordinarily severe test for any coating, and while not likely to occur once in a thousand instances, yet the coating that has endured it successfully is a good one to adopt for any fine structure.

43. A similar composition of varnish as the above (Ritchie's) is manufactured by Edward Smith & Company, under the name of "Durable Metal Coating," composed of asphaltum, Kari gum, linseed oil, and turpentine, compounded by a moderate and long-continued heat, until the several substances are thoroughly incorporated together, and the albumen and other impurities are removed by evaporation or deposit. This coating contains no pigment or foreign substance in its composition, is strictly a varnish, and, as a protective coating applied with a brush, is secondary to none. The best result from its application is when the material coated and the compound itself are moderately warm, as in the sun on a hot day; a result that is equally noticeable with any good oil paint.

44. The literature of protective coatings has been greatly enriched by Edward Smith & Company's publication as a trade catalogue of the discussions on "Protective Coatings for Iron Work," by Prof. A. H. Sabin, M.S. (Member of the Society and late Professor of Chemistry in the University of Vermont), read at a meeting of the New England Railway Club, Boston, Mass., and before the American Society of Civil Engineers, New York, 1895. It is possibly a too radical departure from the old-time methods of protecting ferric structures by the paint brush and a pot of some sort of compound called paint, for many engineers either in construction or in charge of repairs, to consider the merits of a baked japan coating such as is described by Prof. Sabin, under the name of "Baked Coating," which has proved to be so reliable to prevent corrosion under hydraulic and underground tests. The process is peculiarly adaptable for all the chord eye bars, lattice posts, struts, and other members, which in position are so closely set together, or from their lattice box form, that their actual condition on the inside surfaces can never be ascertained, only guessed at, and can never be either inspected, scraped or repainted in such a manner as to insure their being absolutely protected against corrosion which, once established, must proceed, and this, too, on the very parts of the truss on which its strength is dependent. From the disturbed condition of the iron or steel at the eyes of the chord bars due to the operation of forging, the metal at these points is affected and not in its normal condition as relates to the body of the bar, which is as it left the rolls. These eye bars have been found to be unequally affected by the local galvanic action set up in all bars of iron or steel under stress, and become electro-positive at or near the eyes and welds where the metal has been most disturbed in forging, and this action seems to concentrate the corrosion at those points if there is any deficiency of the protective coating at or near these points to localize it. The electro-motive force between the body and eyes of a tension bar has been found to range from 0.003 volt to 0.023, 0.019 being that due to soft Bessemer steel from which such bars are generally forged. The position of these bars as to their magnetic polarity has been found to manifestly increase this electro-motive force at times to nearly double these amounts, and this ever-present element always ready for duty may be the agent which has caused some inexplicable instances of corrosion like that where 5 inch by 1 inch bars have corroded beyond the limit of safety, and other instances where holes nearly an inch in diameter could be cut through the bar.

45. The edges of all channels, angles, tees, and other special truss forms are a well defined round, and when closed together or to plates or bars in the many types of bridge construction, form at their intersection a re-entering angle or groove, instead of a salient one. Besides, the rough edges of these forms and this rough re-entering angle are hard to paint, as the paint will not flow down into them of its own volition, and the painter is generally too careless to fill them with his brush even if the confined strip of air did not refuse to escape as the paint-loaded brush is drawn over it or slapped on it. Particularly is this the case if the surfaces are cold or damp. These places are not few in number and of no moment, but are to be found by hundreds of lineal feet in any structure of magnitude, and are almost invariably the seat of corrosion. They are seldom scraped out in repainting the structure; the ballast and street dust, cinders and ashes from the locomotives find ready lodgment at these points, and are not washed out by the storms, only kept moistened and ready to commence their corrosive work at the earliest moment possible. The destructive carbonization of bituminous coal for coal gas, or for hard foundry coke, only eliminates about one-half of the sulphur in it, the other half being found in the resultant coke. About one-half of this remainder is consumed in the high heat of the locomotive fire box, and the balance is found in the ashes and cinders. The soft coal used on many railway lines often contains 4 per cent of sulphur, and a solution from the ashes and cinders is strong enough to redden litmus paper. Small wonder that many bridges are in an advanced state of corrosion within ten years of their erection.

46. There is nothing impracticable in applying a baked japan coating to all these parts of a railway truss, except, possibly, the end posts and top chords which require to be riveted up in position. The floor beams, stringers, etc., could receive the same treatment, while the added protection from this process manifest in the lessened amount for materials and labor in the frequent repainting of the structure, would probably equalize the cost as compared with paint within comparatively a few years.

47. Whatever its cost per square foot of surface, there is no doubt that all parts of the iron work used on the underground railway system now under construction in New York city, which is covered in and out of sight, and cannot be readily inspected at all times, should receive a baked japan, or other enameled, or Bower-Barff coating, particularly the roof girders, beams, and covering plates, as well as all the iron, which is embedded in mortar or cement, which in these locations will always be moist, so that caustic action from the lime, mortar, and hydraulic cement will disastrously affect the ordinary oil coatings in contact with them. Once closed in, there is no remedy for corrosion except another upheaval of our city streets, and an added burden of discomfort and debt, which in all reason, with our past engineering experience applicable to the needs of the day, we ought to be able to avoid without a special act of the Legislature, or the consent of a political boss.

48. In a paper read before the Newcastle, England, section of the Society of Chemical Industry, Mr. Henry Smith, F.I.C., described a series of experiments upon the protective powers of 27 different English commercial paints, as applied to iron work in 50 separate instances. Reprinted from The Engineer (London) by The American Gas Light Journal, September 4, 1899. The methods of test were those devised and employed by Mr. Max Toltz, C.E., in a series of experiments upon a number of American commercial protective coatings for iron, the deductions being embodied in a paper read by Mr. Toltz before the Society of Civil Engineers, St. Paul, Minn., and reported in The Journal of the Association of Engineering Societies, 1897, reprinted in The American Gas Light Journal, September 20, 1897. Three sets of bright and clean iron plates, all of the same size, were respectively coated with the several paints, in all cases furnished as a stiff paste in the proportions of pigment and oil, as herein given, and when applied, were brought to the consistency of a paint by mixing with genuine boiled linseed oil, capable of drying in *seven hours under ordinary conditions of temperature*, no driers or turpentine being used. The first coat was allowed to dry thoroughly firm before the second coating was applied. When this was firm and hard, one set of the plates was exposed to the weather, as in ordinary cases of painted structures. The other two sets were treated as follows: One set was simply to corroborate the results obtained from the other set; the results being practically identical in each case. Each painted strip was placed in a clean, wide-mouthed glass bottle, half filled with clean, pure water. The bottles were not closed, but were protected from the entrance of dust and impurities while allowing the air free access to the painted plates. Several of the plates had commenced to corrode in about a week. This was indicated by a cloudiness in the water, which afterward became further oxidized, and formed a red precipitate of ferric oxide or rust, which subsided partly to the bottom of the vessel. After three months exposure the plates were removed, and the liquid in each bottle together with the sediment was tested for the percentage of iron present in the form of rust.

49. The figure given as denoting the amount of corrosion is less than the actual amount, as it does not include the portion that adhered to the plate, which was not scraped or brushed to remove the portion that would not drain off. In each case, the weight of rust was calculated to pounds of rust, per

1,500 square yards of painted surface, the other figures give the percentage composition of the several paints by weight.

Twenty mixtures of barytes alone, or with calcium carbonate mixed with Celestial blue, Prussian blue, chrome yellow, raw sienna, Vandyke brown, Italian ocher, Brunswick and other greens, chromate of lead, English umber, Turkey umber, ultra-marine, Chinese blue, burnt sienna, mixed with raw oil in proportions from 11 per cent to 51 per cent of the weight of the paint; the corrosion in the order named above ran from 168 pounds to 441 pounds per 1,500 square yards of surface.

50. Except in the case of the blues, umbers, siennas, etc., where the pigment had but little influence on the oil to resist decay beyond that inherent in the oil alone, the more separate substances that entered into the composition of the pigment the more unreliable it became. A single exception is noted in the case of a Venetian red paint, made from barytes, calcium carbonate, and a small amount of iron oxide, that gave a better result than barytes alone, or when barytes was mixed with the other color pigments of much less specific gravity. Several substances in a composite paint are generally fatal to its protective qualities, no matter to what it is applied. The several atoms of these substances, even if uniformly distributed in the pigment in the process of grinding, bolting, and mixing (but they are not), will retain their juxtaposition, when mixed with the oil, only momentarily, the heavy atoms will sink, and there will be a marked difference in the coating spread from the top of the paint in the pot from that in the middle or bottom; the lighter and most perishable substances will get on the surface first.

51. Barytes worked well with red lead and zinc oxide, there being but a small difference in their specific gravities as compared with barytes and the other color or base pigments. With white lead, as the percentage of barytes was increased, so was the corrosion. Aside from the reduction in cost of these lead and zinc pigments by the addition of barytes there is no reason for its use, and the barytes alone did not give a satisfactory test. No doubt from the splintery character of its atoms, as has been commented upon, it is wholly destitute of covering or color power. The vagaries of the iron oxide paints in the varying proportions of the pigment and oil are noticeable, but not so marked as where barytes, one of the heaviest of all pigments, and calcium carbonate, one of the lightest, both classed as inert pigments, were mixed with the oxide, and fully sustain the previous remarks upon the non-protective character of composite and iron oxide paints. Boiled oil, in the single instance reported, proved superior to raw oil as a vehicle for the several iron oxide paints in the ratio of one to nearly five.

52. A second series of experiments were made by the same experimenter, and following the method of Mr. Max Toltz, C.E., to wit: A number of iron dishes five inches in diameter and one-half inch deep were scoured bright, and then coated with two coats of the several paints used upon the above detailed iron plates and under the same conditions as to the composition and drying of the paints. These shallow dishes were filled with water and allowed to completely evaporate in the open air of the laboratory. This operation was repeated six times in the course of six months. Thus tested, the only paints which remained practically unaffected were red lead and orange lead paints, some of which, however, such as the "vermilionette" and scarlet red paints, contained also a proportion of aniline colors, while two of the red lead paints contained in the one case 45 per cent of barytes and in the other 66 per cent. All the other dishes were more or less rusted, the order of merit of the better paints being as follows:

1. Zinc oxide.
2. Equal parts zinc white and barytes.
3. Zinc white, 3 parts; barytes, 7 parts.
4. Lithopone (a mixture of zinc sulphate, zinc oxide and barytes).
5. Pure white lead.
6. White lead, 5.37 parts; barytes, 4.03 parts.
7. White lead, 5.05 parts; barytes, 4.21 parts.

All the other paints, thirty-six in number, proved inefficient. The first to show rust was that one painted simply with linseed oil. The above classification of merit is by Mr. Smith, and, taken together with the detailed report of the glass bottle test (before given), may be considered a fair representation of the protective qualities of the hundreds of commercial paints foisted upon the market under various trade-mark names in the United States as well as in England, where the above experiments were conducted.

53. Both the immersion and dish tests are very important for determining in a relatively short time the weather-resisting power of a paint. If the coating is unable to resist the action of water or moisture in the form of steam, fog or vapor from a tunnel or other confined space, it cannot be desirable for the protection of a ferric structure, or even a wooden one. The dish test probably is the nearest to the actual condition which a paint must withstand. When the water in the dish is nearly evaporated there remains in the circular seam of the bottom a film of water which contains the carbonic acid and the decomposing gases and dirt from the atmosphere, which acts upon the paint in such a way that the coating at that part is soon permeated and rust forms. This action is more and more developed after each evaporation, and practically covers the whole dish in a short time. In actual service the same thing will happen. The corner of the dish finds its counterpart in every corner of a ferric structure where two plates, angles, or other parts join. Rust will commence at those seams and extend under the paint, but will not show as plainly on a bridge truss as on the small dish. The shallow dish tests by Mr. Max Toltz, C.E. (before referred to), were made prior to and during 1897, and extended over a period of from six months to two years. Without entering into as great detail as that quoted from Prof. Smith, the deductions from his tests are in brief. Twenty-two different paints were submitted to test under the following classification:

No. 1. True asphaltic varnish paints compounded by heat in the same manner as a black baked japan, and practically of the same nature and comparable therewith. No corrosion reported after the dishes had been filled and evaporated naturally fourteen times.

No. 2. So-called asphaltic varnishes, or paints of inferior qualities to the above No. 1, made from asphaltum dissolved in benzine or other volatile menstruum, *but were not a true varnish*. They contained about 43.5 per cent of vehicle and 56.5 per cent of asphaltum. As a rule they showed well in the beginning, but after the volatiles had evaporated, especially when subjected to a moderate heat test, the coatings became quite brittle, were easily removed by abrasion, and did not protect the surface covered with them. Their composition varied in the several specimens tested. One sample analyzed had *no asphaltum* in it. Under test the dishes painted one coat showed considerable rust all over after the fifth exposure. Those painted two coats after the seventh exposure showed not much better. Generally their reliability as protective coverings for ferric structures is the least satisfactory of all paints.

No. 3. Black carbon paints, in which the vehicle was practically a varnish, the carbon black and other pigments being ground in a practically linseed oil varnish, and are comparable with No. 1, to which they are closely related. The dish painted with only one coat showed a little deterioration at the end of the fourteenth evaporation, while the dishes painted two coats were uninjured, the coating being as elastic and tough as when first applied.

No. 4. Iron oxide paints consisting of more or less iron oxide with more or less silicious matter, and compounds of lime and magnesia. They were of different grades and qualities, were as a rule well ground and spread well. Under test the dishes painted one coat after the fifth exposure many rust spots appeared. Those painted two coats were refilled six times, and on them the rust was plainly discernible to the eye.

No. 5. Graphite paints and silica graphite compounds. These paints were received from the several manufacturers in the form of a stiff paste, and when mixed, ready to apply, 4½ parts of paste to 3½ parts, by weight, of boiled linseed oil was used. The dishes painted with one coat were evaporated ten times. After the fifth evaporation a few specks of rust were noticeable, and the number gradually increased after each successive evaporation. After the tenth exposure some slight difference between them was noticeable, but not much. The dishes painted *two coats* were exposed thirteen times in two years, and none of them showed any rust or indication of rust. The natural toughness and elasticity of the paint still remained.

54. It will be noted that there is a wide discrepancy in the results of the dish test of Mr. Toltz, as above, of the graphite paints, both the natural amorphous pigments and the compounded silica graphite pigments, and the plate test given by Prof. Smith of *pure flake graphite* mixed with *raw linseed oil* that gave 215 pounds of corrosion to 1,500 square yards. This, no doubt, is due to the repellent nature of the pure flake graphite; the pigment does not take kindly to the oil, no more than soapstone does. Raw oil, even if pure, contains over 7 per cent of water, that renders a combination of the graphite and oil quite uncertain unless under the influence of heat. The boiled oil vehicle with pure flake graphite, used by Prof. Spennrath in his experiments (before referred to) with paint skins detached from the metal surfaces, withstood an exposure in a pure water bath for six weeks without injury other than a slight loss in weight of the skin. Moisture in the oil in this case was eliminated, as in the case of Mr. Toltz's graphite paints, and the merits of boiled oil as a vehicle for most paints over raw oil are sustained in these experiments, as it is in daily practice elsewhere.

55. The result of these tests corroborates the series of tests made by order of the Secretary of the United States Navy in 1884-5.* By request, sixty paint firms submitted seventy-five different paints for test, which were applied to five hundred test plates, and then immersed in sea water at four navy yards, and upon one government vessel in service. The paints that successfully withstood the test and received an *order of merit* were red lead, zinc oxide, carbon, and graphite compounds. The so-called asphaltum paints were at the bottom of the list in the *no merit column*. Evidently there has been slight improvement, if any, in this class of paints since the date of the United States navy tests to the present time, and one can but wonder in the face of repeated and recorded failures that they ever receive an application to a ferric structure, ashore or afloat. Lead, zinc, carbon, and graphite compounds maintain their supremacy for government work, and particularly the amorphous Superior Graphite paints that have been selected by the Navy Department for the war color of our battleships and other war vessels, and for the gun carriages and other ferric bodies that line our thousands of miles of coast defenses. In other tests of commercial and special paints, where the tests have been carried to the destruction of the coating as a whole, the partial destruction of the menstruum was generally followed by the disintegration of the weaker substances comprising the pigment, such as the carbonate and sulphate of lime, asphaltum, iron oxide, and the various color pigments, viz., the ochers, umbers, blues, greens, carmines, yellows, etc. The only pigments practically unaffected by the destructive element were the graphites; the silica, barytes, slag, slate, brick-dust, and other adulterants were but little affected, some of them being partly recoverable, which was also the case with the red lead, white lead, and zinc oxide pigments. Pure water is a greater destructive element to an oil coating than solutions of sal-ammoniac, or chloride of magnesium, common salt, or natural sea water, if free from sewage, all of which are generally classed as agents of destruction. The salt decreases the action of water on an oil coating, the destruction of which is hastened by mechanical action if the water, either fresh or salt, or the other solutions are in motion. Ordinary commercial oil coatings are destroyed by diluted muriatic and nitric acids, alkaline liquors, ammonia, sulphide of ammonium, soda, caustic alkalies, and alkaline solutions of coal ashes, clinkers and cinders, soot, etc. Diluted sulphuric acid does not materially affect an oil coating. All gaseous acids destroy the coating quicker than the acids in diluted aqueous solution, the destruction being in all cases hastened by heat or motion. Hence, to determine the probable protective value of any paint or other coating, it is necessary to know the detrimental influences to which it is to be subjected.

56. Objection is made by some engineers and paint manufacturers to these methods of testing paints; that they do not meet the actual conditions of coatings exposed to weather. That a ferric structure is not always wet, but wet and dry, with more dry hours than wet, etc. This would depend altogether upon the location of the structure, and in many instances there might be more wet or damp hours than dry ones. A fog or long continued sweat is more destructive to a paint coating than a passing storm. But the plain fact remains that these tests (and many others, the details of which are not given) are all competitive as between different commercial paints, and under uniform conditions. The trial given one paint was given to all; the few successful ones that head the list are the better ones to select from to base any subsequent improvements or experiments upon, or for use. One manufacturer remarked when the result of the test was given him: "If I had only known that my paint was to have been subjected to any such test I would have furnished a different sample." Just so, and it *would not* have been such as he was selling, possibly under a catchy trade-mark name, at a high price per gallon, with loud claims for its superiority. The water test settles the merit of a protective coating in short order, and so soon as generally adopted by those ordering paints for the protection of ferric structures exposed to weather, so soon will the great majority of these patent paint compounds cease to vex the engineer with high claims and low performance.

57. The nearer any protective coating approximates an enamel or varnish, generally the more durable it will be. The Japan and Chinese lacquers are varnishes, and dry better by the application of water than in dry air alone, and all compounded varnishes are hardened in the last stages of their drying by water. Lacquers, when thoroughly dry, remain unchanged for scores of years, when exposed to either fresh or salt water, hot or cold, alternately wet and dry, or immersed. The coming ferric protective coating will probably be a true varnish with a carbon or graphite pigment. But it will be well to bear in mind that it will not be imperishable in exposed locations, and that its application and the preparation of the structure to receive it will require more attention than at the present time these matters generally receive, neither will it be a low cost article.

58. Stress is laid by many engineers and master painters upon the fact that the use of raw oil in a paint allows it to be applied to a surface that is moist, damp, or frosty, with better results than when the oil is boiled, as the raw oil having more or less water in its composition naturally will take up an added portion which is on the surface being coated; hence the additional moisture is of no moment, as it would be in the case of boiled oil in which most of the moisture has been expelled in the process of boiling, and when so expelled and cold, refuses to take up again any noticeable amount of water *when a pigment is present*. All the moisture in any paint vehicle, be the same more or less when the paint is spread, must be eliminated by evaporation alone, not an atom of it enters into the resinification or drying of the coating. This evaporation of the water, whether that contained naturally in the raw oil or the added amount striven to be incorporated with it by the paint brush, in the process of drying, must escape as a vapor of more or less tension; its exit through the vehicle, be the same more or less elastic as all drying vehicles are, can only be as a vapor, and not as a liquid, in drops however minute. This outward passage of vapor leaves the menstruum porous, and where moisture can pass out, moisture can go in; there is nothing in the nature of a porous drying menstruum that takes the function of a back action check valve to keep moisture out. If the coating has hardened externally by evaporation or resinification before the temperature of the coated body is raised to that degree to allow the vaporous moisture to escape, then its course is reversed, and the moisture will be found next to the coated surface whether it be of wood or iron; the coating as a whole is pushed up and a blister formed, which in the case of a ferric body always denotes the first step toward corrosion. Again, raw linseed oil consists of oleic, margaric, and stearic acids, united to a common base—glycerine. This base is hygrometric and unites completely with water or moisture in any proportion presented to it, whether from the atmosphere or other sources. When various pigments such as the salts of lead (lead carbonate, lead hydrate, etc.) are ground with raw oil, these salts unite chemically with the oleic acid to form linoleate of lead. As a consequence of these decompositions in linseed and other siccative oils, the margaric and stearic acids (called fatty acids) are set free, likewise the base, glycerine. The fatty acids are absorbed by the linoleate of lead (or lead soap); the glycerine, however, does not unite chemically therewith, but is merely suspended in the soap mass, which, as it gradually absorbs oxygen from the atmosphere, hardens into a skin, and as the hardening proceeds, the glycerine is gradually expelled from the lead soap, and with its load of moisture will be found under the skin of drying oil or paint as a blister loaded with the oxygen necessary to establish a full-fledged product of corrosion.

59. There are other salts of lead and other pigments which absorb a great portion of the eliminated glycerine, but not *all* of it. Red lead, however, *does absorb it all*, and it is for this reason that red lead is so reliable as a single pigment water-proof coating for preventing corrosion under ordinary circumstances. Iron oxide, however, only partially absorbs the glycerine, though in a gallon of iron oxide paint there is more combined oxygen elements than in a gallon

* Trans. A. S. M. E., 1894, vol. xvi., paper No. 625, pp. 399-402.

of red lead paint. It is the uncombined glycerine that is the prime cause of the unreliable character of a paint coating to resist moisture and consequent decay of both the coating and the body covered. Varnish menstruums, though carrying the same pigments as an oil paint, are more reliable coatings, for in them the glycerine has been eliminated in the process of manufacture. It is the presence of glycerine in a raw oil paint that renders it possible to mix more or less water and soapy compounds with it as vehicles, and it is the function of a drier added to a paint, for the drier to combine with or mechanically absorb the glycerine, so that the union formed between the fatty acids of the oil and pigment shall harden and dry. All additions to a paint in the form of free or bung-hole driers, lessen its stability, increase the chemical action that in a greater or less degree is present in all paints, and generally means the introduction of an acid element not at all necessary in the composition of any paint to render it protective or to harden it when spread.

60. The use of boiled oil as a vehicle simplifies the chain of operations greatly in most paints, as it insures the absence of many substances injurious to the coating, other than those natural to the pigment. Of itself, it may not be as durable, either in the form of an oil skin coating or a pigment coating in place, as compared with others from raw oil, that have time to dry *naturally*, without the use of driers (generally three weeks, and that is not always possible to allow), but there is no question of its superior quality as a menstruum as compared to the ordinary commercial raw oils (many of them should be classed as unguents instead of oils), loaded with driers, many of which are of the most unreliable character, and only induce in the drying oil a chain of mechanical functions, not chemical combinations, that ought to be confined to the boiling kettle.

(To be continued.)

RESISTANCE TO DEATH AMONG INSECTS.

AFTER every capital execution in Paris, the body of the decapitated person is generally sent to the members of the Academy of Medicine, in order to be submitted to various experiments, such as upon the persistence of the motions of the body after the head has been separated from the trunk.

Similar researches have been made by Signore Canestrini, an Italian scientist, upon insects. Having collected a large number of specimens, he cut off their heads with either a pair of scissors or a bistoury. This operation, very easily performed upon certain insects, such as diptera, hymenoptera and orthoptera, is, on the contrary, very difficult with certain others, such as chrysomelids and cryptici.

Signore Canestrini observed that the motions of the head and body, which were at first very evident, became much more difficult to verify after a length of time that varied according to the insects upon which he experimented. When all motion had ceased in the two separated parts, the experimenter had recourse to artificial means, and pricked, pinched and pressed and enveloped them in tobacco smoke. In this way he often succeeded in causing motion in parts that were apparently completely insensible.

All the insects did not behave in the same way after being decapitated. The coleoptera rolled around upon the back almost immediately. The pyrrhocoris, on the contrary, remained upon their legs, and the crickets staid in such a position until after death.

A few active insects, such as ants and bees, remain almost completely immovable after their head has been cut off, and it is not until a long time afterward that they appear to feel the amputation that they have suffered. The lepidoptera and diptera appear to support this operation with the greatest indifference.

Signore Canestrini has seen butterflies fly for eighteen days after decapitation, and crickets jump after thirteen days; and he has observed the *Mantis religiosa* moving after a decapitation of fourteen days. The accompanying table gives a resumé of a number of observations of movements among decapitated insects. The figures given show the result of experiments repeated upon a large number of individuals of the genus or species cited. For the sake of brevity, only the genus, with the common or scientific name, is sometimes mentioned.

	Duration of the Motions. Motions of the body.	Motions of the head.
Geotrupes stercorarius	5 days	16 hours.
Cetonia aurata	9½ "	4 "
Silpha obscura	6 "	12 "
Harpalus	60 hours	10 "
Butterflies (various)	18 days	several "
Ants	30 hours	30 "
Wasps	5 days	24 "
Bees	40 hours	several "
Bombyx	30 "	3 "
Flies	36 "	6 "
Gad-flies	27 "	8 "
Mole-crickets	9 days	78 "
Earwigs	11 "	6 "
Grasshoppers	8 "	48 "
Mantis religiosa	14 "	60 "
Pyrrhocoris apterus	4 "	several "

From this table it will be seen that the duration of the motions of the head is always less than that of the motions of the body.

In certain insects the sensitiveness is preserved until the last moment of life. If the extremity of the leg, or even any other part of the body of a cricket, be slightly touched, it will be seen to rise at once, an evident sign that it has felt the touch, and if the act be repeated it will begin to jump. The head also preserves a wonderful sensitiveness for a long time, and this is manifested by the motions of the antennæ and palpi.

The liquid which exudes, sometimes in abundance, either from the head or front part of the body of decapitated insects, neither retards nor accelerates the extinction of the motions. Signore Canestrini, after decapitating his insects, sometimes allowed the liquid to escape freely and sometimes prevented the flow of it by means of wax. In both cases the duration of the motions was exactly the same.

Humidity and a mild temperature preserve the softness and vitality of the body and head, while dryness and heat (18° or over) in a short time render these parts rigid, fragile and insensible. There are probably exceptions to this rule, but it is certain in the case of crickets and grasshoppers that, if as soon as they are decapitated, they are put into damp earth, and in cold weather, they will resist longer than if they are placed in dry earth in dry weather (cold or warm).

M. Devaux, a French physiologist, has made some experiments in order to ascertain whether resistance to submersion would be as great. When an ant is drowned it manifests evident nervous troubles by various motions. One of the most curious movements that it is seen to make is the bending of the body double, so that the abdomen comes into contact with the mandibles. It bends itself in this way from three to five times during the very short period that it takes to effect the complete drowning. Afterward it remains entirely inert. If the insect then be taken from the water it will soon exhibit a few feeble and non-co-ordinate motions. In order that the return to life shall occur rapidly, the insect must be placed upon blotting paper, which will absorb the water from its body. At the end of from five to ten minutes it will begin to walk and be perfectly restored.

If the submersion lasts for some hours, say from six to eight, it will take longer for the ants to return to life. In fact, it often requires more than half an hour. The direct heat of the sun seems greatly to favor their restoration. At the end of an hour, or an

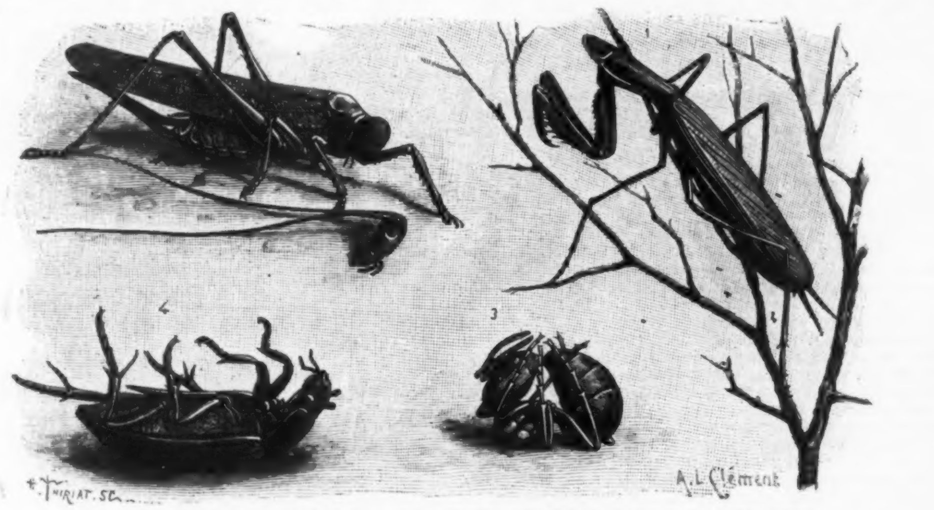


FIG. 1.—1. MANTIS RELIGIOSA. 2. GREEN GRASSHOPPER. 3. RED ANT. 4. BROWN HYDROPHILUS.

hour and a half, their recovery from the effects of the submersion will be complete.

If the submersion lasts longer, say for twenty-four hours, the majority of the drowned ants will be seen to return to life. The first motions are shown at the end of half an hour or three-quarters of an hour, but seem to be involuntary, and it is often necessary, in order to observe them, to use a magnifying glass.

If an ant be slightly excited while it is exhibiting these feeble motions, by tickling it with a feather, for example, it will be seen to become agitated and try to look around it like some one who is awakening. Such excitation greatly accelerates the return to life. If the insect be touched only from time to time it will soon be seen that it appears to be surprised and will turn away from the side on which it has been touched. But it will quickly return to its somnolence. If the excitation is begun again, the insect will become more greatly agitated and may even try to bite the feather. Fatigue quickly supervenes, however, and, after two or three active movements, the animal ceases to struggle. But it is soon seen trying to take a few steps or even to clean its legs and antennæ. When, at the end of two hours, an endeavor is again made to excite it, the animal runs over the feather, or turns about in a threatening manner if the attack is made from behind. The complete restoration takes place within a time that varies with the duration of the immersion, say three, four or more hours. The duration of the submersion may be greatly prolonged (for fifty or sixty hours, for example). In such a case, it is still possible to bring certain individuals back to life, although there are others which, after exhibiting a momentary resuscitation, die for good at the end of one or two days. "I have," says M. Devaux, "observed a momentary return to life exhibited after 110 hours of submersion. Out of three ants that had remained inert at the bottom of the water from six o'clock in the afternoon of May 9 till eight o'clock in the morning of May 14, one ant exhibited very distinct movements at the end of a few hours passed in the open air. This ant was therefore still alive after passing about five days under water."

We might be led to believe that the resistance to asphyxia by submersion is greater still among insects that usually live in water and come to the surface to breathe only from time to time. But the experiments of M. Devaux have shown, on the contrary, that aquatic insects are less resistant than ants. Hydrophilida and Dytiscidæ placed for ten hours in running and aerated water without a possibility of reaching the surface to breathe, have exhibited only a few motions of the legs; but a complete restoration has not taken place and the insects have died two days afterward.—For the above particulars and the engravings we are indebted to La Nature.

FIG. 2.—1. DIPTERA—VOLUCELLA ZONATE. 2. COLEOPTERA—CHRYSOMELA OF THE POPLAR. 3. PYRRHOCORIS APTERA. 4. OX-FLY. 5. PIERIS. 6. STAG BEETLE. 7. CLICK BEETLE. 8. FIELD CRICKET.

German Potatoes for America.—Consul Warner reports from Leipzig, April 16, 1901: Potatoes are being exported from this section to the United States for the first time this year. So far, the shipments made have been small, but the indications are that the volume will increase. Orders for next season are heavy. The German potatoes are smaller than ours. Those exported as known to the trade as "old potatoes" and are to be used almost entirely by the large hotels for making potato salad. Americans should supply this demand by purchasing seed potatoes here and raising them at home. They could be sold at a greater profit than is made on the potatoes now grown, as the Germans can afford to raise them, pay freightage and our import duty of 25 cents a bushel, and still find the business remunerative.

RECENTLY DISCOVERED GREEK MASTERPIECES.

THE remarkable discovery of ancient Greek statues in the sea off the island of Cerigo, the ancient Cythera, has added several more masterpieces to the rich store of ancient art treasures with which the last few years has furnished us. In these latter days, the excavator and the diver have presented us with a greater number of specimens of ancient statuary, especially bronzes, that are fully representative of the spirit of Greek art, than all the centuries since, in the Italian renaissance, works of art were sought for and treasured. It is to four of these recently discovered statues, each of them unique and typical of the several periods of Greek sculpture to which they belong, that I wish in this short article to draw especial attention.

For in support of what I have just said with regard to the discoveries of recent years compared with those of former centuries, it is important for us to remember that the works we are here discussing are originals and not ancient copies. The specimens of ancient art upon which previous generations formed their estimate of Hellenic art—an estimate as sincere and lofty as it bore fruits in a refined enthusiasm for things beautiful—were, with but few exceptions, ancient marble copies of a late Greco-Roman period. More than nine-tenths of the much admired statues that fill the museums of Italy and the rest of the Continent are not works of original Greek sculpture, but are such Greco-Roman copies.

The Elgin marbles, coming to us at the beginning of this century, were a revelation, and marked the turning-point in archæological study and in artistic taste. Indeed, so much were they a revelation that the connoisseurs and dilettanti, the canons of whose taste were based upon the Apollo Belvedere and the Venus dei Medici, entirely failed to recognize their supreme beauty, and that it required the militant support of a few isolated sculptors of the day to win a reluctant recognition of their supreme value.


MARBLE FIGURE RECOVERED OFF CERIGO.

But the Elgin marbles as well as the Æginetan statues now at Munich, the Phigalean frieze in the British Museum, the sculptures from the Mausoleum of Halicarnassus, from the Temple of Nike Apteros at Athens, etc., are works of decorative or architectural sculpture, not of pure statuary—they were not the masterpieces from the hands of the great sculptors upon which these based their fame. High as we may place these architectural sculptures among all the extant works of art—and nothing can surpass the Parthenon marbles as specimens of sculpture—it is important for us to remember that they were works of decorative art, and that in so far they do not fully represent the supreme qualities of a Pheidias, a Scopas, a Praxiteles or a Lysippus, which these artists put into their famous works of pure sculpture.

The question naturally suggests itself why these hundreds, nay, thousands, of marble copies from ancient times which fill our museums should have remained extant and not the originals? The answer to this is a simple one. In the highest period of Greek art, during the fifth century B. C., marble and stone were not the materials in which the great sculptors put their highest artistic ideas. The material used for the great works of sculpture (having in the earliest times been chiefly wood) was gold and ivory or bronze—gold and ivory for the chief temple statues and bronze for out-of-door monuments, especially the statues representing athletes. Marble, which was used for architectural and decorative sculpture, was in the fourth century more and more introduced as material for works of pure sculpture, until with Scopas and Praxiteles it became a favorite material; while, toward the close of the century with Lysippus, bronze, at all times holding its own, again predominates. But even with Scopas and Praxiteles the marble statue was not the same as it is in our days. For, exquisite as the modeling undoubtedly was (this the Hermes alone shows us), the coloring and tinting formed an integral part of the artistic elaboration: it was a technique so highly developed and so refined in its application that even the trained archæologist can hardly form an adequate conception of its effect. Still, these great marble statues of Scopas and Praxiteles were not numerous. Exposed as they were in their central position of the shrine, they readily fell into the hands of the iconoclast. When we remember that the architectural sculpture which has come down to us owed its preservation to the fact that the buildings to which it belonged became converted into churches and mosques, and that even so the proportion of extant works is infinitesimally small, we cannot expect many of the great marble statues to be preserved to us. The Heræum of Argos, for instance, in the metopes and pediments, must have contained over one hundred figures. We considered ourselves fortunate in discovering seven complete heads and two torsi, besides numerous smaller fragments.

We must thus never forget that the chief works were of gold and ivory and bronze; and it can readily be realized that the barbarous hordes sweeping over classic lands melted down and utilized all the metal wherever they could find it. While we must therefore be grateful to the Greco-Roman copyist for having with his inferior handicraft preserved for us some record of the masterpieces of ancient art, we must be all the more elated when kind fortune brings us face to face with a Greek original. These at once manifest their superiority so strikingly that every original work, even though it be by a less famous artist and of a more degenerate period of ancient art, is naturally supposed to be by one of the greatest artists and of the highest period. So, for instance, the glorious Venus of Melos in the Louvre Museum, though I believe it to be a work of the Hellenistic period (drawing, it is true, its inspiration from the great art of the fifth century B. C.), has been attributed to every great sculptor from Pheidias to Praxiteles; and it is hard for us to realize that the equally glorious Victory of Samothrace, in the same museum, was probably by an artist of the second flight, and is not earlier than the close of the fourth century, B. C.

When we realize these facts regarding Greek sculpture we are better prepared to appreciate the important discovery of an undoubted Greek original. Since the Germans excavated the Hermes with the Infant Dionysus at Olympia in 1877, which presented us with an undoubted original work (though not one of his famous ones) by the master Praxiteles, nearly every year has yielded up some new treasure from Greek soil; and now we have presented to us a number of original statues, among them life-size bronzes, one of which is undoubtedly of the same school, if not by the same hand, as the Olympian Hermes, and can claim to equal if not to surpass it in the peculiar noble grace and charm of the art of the Praxitelean period.


BRONZE HERMES RECOVERED OFF CERIGO.

The discoveries off Cerigo have not been completed; they have only been begun. Who knows what the depths of the sea may yet have in store for us? The lucky accident which led the sponge-diver to discover this treasure is now replaced by the designed skill of capable archæologists. The work is in the hands of the Director-General of Antiquities, Mr. Cavvadias, whose researches hitherto have been as thorough as they have been successful. With him and M. Stäis, as the Minister of Public Instruction, we can feel sure that the work is in good hands.

Besides the two statues here figured from this find, there are two other interesting bronze statuettes, six marble statuettes, and the torso of a large marble centaur, much corroded by the salt water. It appears that the statues here figured have been comparatively free from the corrosive effects of the salt water, in spite of their immersion for about 2,000 years, because they had sunk into the sandy bottom, where they lay embedded. We may hope that at a greater depth other works will be found in equally good preservation.


FRAGMENTS OF BRONZE HERMES RECOVERED OFF CERIGO.

Some difference of opinion exists as to how these works came to be there, and as to what the ship was that contained them. As we take the one or the other view we come to a difference of nearly 2,000 years. For

it has been maintained by some that it must be the English yacht "Mentor" which in 1802 conveyed a part of the marbles carried off by Lord Elgin and which foundered off Cerigo. But apart from the fact that the chief works hitherto found off Cerigo are bronzes and not marbles, and that we have no record of Lord Elgin's procuring such, we have the well-authenticated assurance of Lord Elgin himself that the cargo had subsequently been recovered from the sea and had been brought to England. On the other hand, Lucian, commenting on the great paintings by the famous painter Zeuxis, had to content himself with a copy when describing the famous picture of a centaur family by that artist, for he tells us that the original picture which Sulla carried off from Greece (no doubt with many other works of art) was lost in a shipwreck off Cape Malea. Furthermore, we have recently heard that the anchor and some of the timbers of an ancient vessel have been brought to light with the statues. It is thus highly probable that the statues now recovered from the sea were those which Sulla once attempted to carry off to Rome. But for this shipwreck it is not likely that the bronzes would ever have been preserved to us.

I. We begin with the most beautiful of these finds. It is a life-size bronze figure of a youth of whom we can here only give the upper half. But what is here presented, including the head, arms and hands, is in excellent preservation. We are glad to hear that both legs have been found, and enough of the remainder of the body to make a complete restoration possible. The correspondent of The Times tells us that "the figure is poised on the left foot, the right being thrown backward; the right arm is extended, the hand apparently grasping a wreath or sacrificial phial."

With this description we are enabled to reconstruct the composition, at least in imagination. But even with what we have now before us we are justified in considering this the finest ancient bronze in existence, perhaps even the finest Greek statue. It at once challenges comparison with the famous marble Hermes of Praxiteles from Olympia. Yet I venture to consider this in some respects a nobler work: for not only the type of the youth himself, but also the conception and execution of the artist, are more virile, less sentimental; and I feel sure that the effect of this statue will grow upon the spectator, whereas that of the beautiful Hermes, striking and bewitching though it may be, is apt to wane, if not to pall. I may at once say that the similarity in the head to the rough, blocked-out character in the modeling of the hair is strikingly similar in this bronze and in the marble Hermes by Praxiteles. And this is so in spite of the difference between the material, which leads to a difference in the style of modeling. The similarity in general character and in all details is such that I venture to ascribe them both, at least to the same school, if not to the same master. But I should not be inclined to ascribe it to the generation of Praxitelean artists immediately succeeding the great Praxiteles. For the son of Praxiteles, Cephisodotus the Younger, is noted for the extreme softness and sensuousness (morbidezza) of his modeling of the nude; while in this bronze I recognize, in spite of the delicacy of modeling, a certain moderateness and firmness of texture in the nude which is even more marked than in the marble Hermes, and may be due to the more athletic conception which the artist has here held of such a youthful figure. We have also heard that some archæologists (among them my eminent colleague of the French School at Athens, M. Perdrizet) have seen in this work characteristics of the sculptor Lysippus. I am bound to say that I can see no trace of this in the work. The mere outline of the head, comparatively large, broader at the top, and tapering toward the chin, is so different from the small, almost circular, heads of Lysippean statues that one might almost contrast this bronze head, corresponding exactly to that of the Hermes, with the Lysippean type. There is thus every reason in favor of, and no valid reason against, the attribution of this work to Praxiteles or the Praxitelean School. This will become more evident as we note the characteristics of the work in detail.

The same may be said with regard to the subject represented in the statue; for though I may at once say that the name Hermes is provisionally as good as any, yet the true meaning of the statue can only become clear when we analyze carefully the composition and execution of the work before us.

To begin with the beautiful pose and composition of the figure, we are, of course, hampered inasmuch as we must not only supply in imagination the lower part of the figure, but we are confined to one aspect and cannot study the statue from all sides. It must never be forgotten that, as a true work of sculpture in the round ought to be perfect and convincingly expressive of action and character from every side from which the spectator views it, so a complete recognition of its meaning ought to be preceded by such an "all-round" examination. In so far what I shall have to say must be received with limitations.

We are told that the figure is resting on the left leg, the right leg being drawn back. On the other hand, the right shoulder is pushed forward, the arm and hand upraised and extended, while the left arm and shoulder are drawn back. This at once gives that cross rhythm (*chiasmos*) to the figure which adds an inner life to the whole composition, and, with this life, repose. The two sides of the figure, as it were, move transversely—right foot back, right arm forward; left foot forward, left arm back. Try by experiment this delicate difference in attitude and composition and you will see how different the feeling of movement and the character of the composition are. If the same arm and leg were extended and drawn back on the same plane, there would not be that play and delicate tension of all the intervening muscles, and the general appearance of vitality would not be as great. At the same time a figure stepping forward with the left leg, the left arm upraised and extended, and the right leg and arm correspondingly drawn back, would give the general impression of an advance which would be strikingly momentary and passing, and would counteract the sense of repose which the "cross rhythm" here gives.

And added to this movement of the body we have the slight bend forward and downward of the head, the eyes looking intently forward, and the head so beautifully posed on the exquisitely modeled neck. If we add this pose of the head to the general movement and rhythm of the body and the action of the hand, the whole harmonizes with the expression of the face, to which it gives clear yet moderate emphasis. This expression of the face is thoughtful, eager, and yet not sensationally emotional; the half-parted lips as if about to speak, the sensitive nostrils that may at any moment quiver with emotion, the eyes directed clearly and attentively toward the people or the things to which the body is turned and the hand is upraised—all bear this out fully. And with all this vividness there is a certain dignity, almost sadness of rhythm and expression, which tones the momentary strain and keenness down to a noble repose.

Nothing expresses this complex and still clear mood and situation more than the outline of the arm and hand. An arm upraised is of itself a marked and momentary movement; it demands strain of muscles especially at the shoulder, and it might easily become too momentary for sculpture, merging into the sensational and theatrical with the total absence of simplicity and sculpturesque repose. This would be the case if an arm were *stretched* out firmly in one straight line, either horizontally or upward or downward, instead of having the varied softer curves in outline from the wrists to the shoulder given with such exquisite modulation and delicacy in the outline of this arm of Hermes. I must ask the reader to try these simple attitudes himself in order to appreciate their import, such "experiments" being the safest guides to the understanding of composition in sculpture.

In this upraised arm we have a bend at the elbow which counteracts the strained, cramped, more violently energetic extension as suggested in the action of muscles at the shoulder. But most of all is this complex, delicate impression conveyed by the wrist. If the wrist were a direct continuation and muscular extension of the movement of the arm, the momentary energy in the action of such a figure would be thoroughly conveyed. But in this statue there is just here a stop of the current, a wave and curve downward, which to a marked degree adds to the reposeful movement of the gesture; and the character of this gesture is finally expressed by the hand.

In an energetic, sensational movement (such as I remember M. Mounet-Sully, of the Comédie Française, habitually to favor), we should have the hand either uplifted from the wrist on, or extended horizontally, or pointed downward. We might say that the hand extended straight with a continuation of the horizontal stretch of the arm would signify positive command; the hand as a whole pointed upward would signify a forbidding command and interdict; the hand pointed downward would mark the announcement of a decision and an appeal to submission. The hand of the Hermes is gently persuasive—half a command, half an appeal for silence; we can almost imagine Marc Antony beginning his speech with this gesture. This hand has neither of the three attitudes enumerated above. The first effect it conveys in outline is that of a gentle curve with no straight angular line, and such a curve of itself tends to soften down the movement, as was the case in the outline of the arm. We cannot perceive much of the inside of the hand, which I feel sure is modeled with the greatest care. Even in this view we can note the delicate indication of the skin between the thumb and the first finger as affected by this position of the hand.

Let us pursue this wonderful work of a great sculptor literally "to the finger-tips." The fingers are spread out in a curved manner. They are exquisitely modeled, long, thin fingers. The thumb is seen in the front view; the two middle fingers are delicately bent together, while the third finger is drooping outward, and the little finger downward. It is not "precious" exaggeration to say that the two middle fingers express more energy, while the drooping of the others counteracts this. If they were all bent equally close together or at equal intervals, they would express a clutch or a grasp.

It has been maintained that the hand has either held some spherical object, such as a ball, or has just thrown it. The Hermes would thus be in the attitude of an athlete about to throw, or who has just thrown, a ball. This is impossible as regards the attitude of the whole figure, as well as the action of the hand. He is not clutching or holding anything, nor is there any indication that he had just held a round object. Try to hold a cricket ball or a larger ball, and you will see how all fingers are equally curved, the thumb included. Throw a ball and watch your hand after the ball has left, and you will again see an equal extension and curve of all the fingers. The gesture conveyed by this hand is a delicate and reposeful movement, calming and persuasive, blessing or praising, or appealing for attention, as clearly as this situation is expressed in the whole composition.

But an ancient statue with an extended hand which does not contain some attribute may be considered so exceptional as not readily to be admitted in this case. Still, if we look about us among works of ancient sculpture, we shall find so many instances presenting similar gestures, that our conjecture may be said to attain the point of certainty. Whoever has studied Greek sepulchral slabs and Greek vase-paintings must realize how highly developed was the gesture-language in real life, and how freely it was adopted in the works of sculptors and painters. The numerous statues of Roman emperors, beginning with the splendid bronze equestrian statue of Marcus Aurelius on the Capitol, the Augustus at Turin, the Marc Antony at Wilton House, the Trajan in Lansdowne House, and many others, though some may have had the hands restored, still point to this gesture. But, leaving later Roman works, we find similar gestures without the holding of attributes in Greek reliefs of the same, and even of earlier periods to which the bronze Hermes belongs. The youth from an Attic sepulchral slab of the fourth century B. C., though the sculptor could not carry out the difficult task of so complex and graceful a pose in relief, is extending his hand in simple gesture to bid farewell or to greet or to bless, while a boy is crouching below. The thumb of the hand has been broken away and reveals the imperfectly modeled inside of the hand, which was never meant to be seen with that clearness.

The arm of the goddess Athene on a relief heading an inscription of the fourth century B. C. is extended in a similar manner; while a small hand of Athene upon which an owl is fluttering shows how a hand holding nothing was dealt with, and is all that remains of a similar heading to an Attic inscription.

Another interesting inscription contained names of youths who had distinguished themselves in the gymnasium of the Palæstra. The heading to this inscription is ornamented with a sculptured relief upon which a male figure, probably a divinity, is crowning the athlete. Beside the male divinity a female figure extends her arm and hand in gesture similar to, though not identical with, that of the Hermes. Above her is the inscription "Eutaxia," which shows her to be the personification of good behavior and distinction in the Palæstra. As she thus personifies the praise recorded on the inscription, the gesture of her arm and hand as well is meant to express and to convey these.

Finally, I would point to one of the beautiful reliefs that was discovered on the Acropolis of Athens in 1877, at the Temple of Æsculapius. Æsculapius is here seated, and before him stands Hygieia. An altar is placed between her and a small adorant who is advancing toward the god and goddess. The goddess, by the gesture of her right hand, is either addressing the worshipers as they advance or is blessing them, and the action of this arm and hand are to my mind as close an analogy to that of the bronze Hermes as we require, at least to realize that it was customary for ancient sculptors to introduce such gestures into their work, and that the attitude of such an arm and hand does not presuppose the "holding of a spherical object."

The left arm of the statue is extended downward. Where the bronze has not been too much corroded, especially from the biceps down to the elbow, one can mark on the right arm the beautiful modeling of the surface, on which the veins are delicately suggested but not coarsely indicated. The hand holds nothing. It is the natural position when a hand is closed and not crampedly balled into a fist. The arm is slightly bent at the elbow and is drawn back at the shoulder, an action which tends to balance the figure stepping forward with the left foot and uplifting the right arm. This increases the effect of equipoise in the "cross rhythm" to which I referred above.

It would be futile at this juncture to attempt to identify this statue with any work by Praxiteles or a member of his school mentioned in ancient authors. We must not forget that but an exceedingly small proportion of the works of ancient Greek artists have been mentioned by the authors that have come down to us. We know that Praxiteles was the sculptor of one Hermes, and it is likely that he made several other statues of that god. The *class* of works to which I should incline to ascribe this bronze is indicated to us by a group of statues which Pausanias* saw in the Temple of Aphrodite at Megara. He there saw the images of Persuasion and another goddess whom they named Comforter, which are works of Praxiteles. But Scopas made the images of Love and Longing and Yearning (if indeed their functions are, like their names, distinct). Near the Temple of Aphrodite is the Sanctuary of Fortune. The image of Fortune is also a work of Praxiteles. The works of Scopas and Praxiteles here mentioned are what might be called allegorical: they are personifications of ideas or emotions. Now, if we could imagine the Persuasion and the Comforter in a male form, it would just be the type which the artist has given to this bronze statue. Moreover, it has been noted before, as regards such more human ideas when personified in a male figure, that the personification of good luck (kairos) by the sculptor Lysippus was probably put in the form of a Hermes, as this, the most human of divinities, was readily the bearer for the different shadings of human life. It is thus that one might, quite conjecturally, define this bronze Hermes by some such attribute as that of Orator or Comforter, *Logios* or *Paregoros*.

II. The fragment of a marble group representing a half-crouching figure, of which the interpretation seems doubtful, was also found off Cerigo. M. Perdrizet considers the statue to be a part of a wrestling group similar to the well-known statues in the Uffizi at Florence. Another view is that the crouching youth is a bowman who has just sent off the arrow. I think we can safely say that the figure in question represents neither of these actions. The youth is crouching down, the body bent forward, the head eagerly upturned; while the left arm is raised upward, and the right arm, the hand holding some rounded object, is stretched downward. The action is so clearly that of combined defense and attack from below upward toward an adversary who fights from above, that it would not require the corroboration of the ancient monuments which I can adduce to show this. The crouching youth held an upraised shield on his left arm, while the sword or spear, more probably the former, was evidently held in his down-stretched right arm; his action being that, at the next moment, he will plunge his sword into the belly of the horse or centaur advancing toward him. It is an attitude which we have in several representations of ancient warriors, of which the beautiful small bronze from the Blacas collection in the Bibliothèque Nationale of Paris, formerly called the Deïphobos, is a representative type. But the nearest illustration is afforded us in one of the metopes from the Parthenon, no longer extant, but preserved for us in the drawing which Jacques Carrey, who accompanied the Marquis de Nointel, the ambassador of Louis XIV. to the Porte, made in 1674. But I would not have it believed that the marble from Cerigo is in its origin *directly* related to the Parthenon sculptures. The modeling of the body and the head, as well as the attitude, are full of life and vigor, and point to a tendency of art not earlier than the sculptor Lysippus in the second half of the fourth century B. C. The numerous battle-scenes presented by Lysippus and Leochares established a tradition which, with the pupils of Lysippus, was engrafted upon the schools of Asia Minor, notably those of Pergamon and Rhodes. As far as I can judge from the

* I. Chap. 43-6.

photograph, I should be inclined to ascribe the workmanship of this statue and group to one of these Hellenistic schools, though I must confess that in the bronze-like treatment of the hair as well as in the type of the face I seem to recognize Lysippean elements.—Charles Waldstein, in The Monthly Review.

P. S.—My friend M. Cavvadias, to whom I had expressed a strong desire to learn as much as possible about the lower portion of the Hermes from Cerigo, has, with great kindness, sent me a photograph of all these fragments, which I have just received. It will be seen that both the legs, exquisitely molded, are well preserved, and numerous fragments of the remainder of the figure. I am assured that, though the cleaning and piecing together will occupy months, the statue will ultimately be complete. C. W.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Packing Goods for Foreign Markets.—(Continued.) Ironware.—(1) Cases, blooms, bundles, crates, barrels. (2) As with general hardware, the cases must be strongly made and secured with iron bands. They are now, as a rule, quite satisfactory, especially those coming to this market from the United States.

Isinglass.—In bottles, packed in the best of cases.

Jute.—(1) Bales, bags, bundles. (2) Bales from India have no covering. The jute and jute tissues are exported from Dundee in the same form as the bales received from India; also from Dundee and elsewhere in bales covered with bagging and hooped with iron. Jute waste is generally in bales or bundles, bound with ropes made of the same material.

Lard.—(1) Tierces, pails, casks, firkins. (2) The oak tierces in which lard comes from America hold about 336 pounds. The lard arrives in good condition if there has been no shifting of cargo from rough weather. Lard comes also in 112-pound casks. The pails, containing 28 pounds, are regarded as very neat packages, and they seldom arrive here in bad condition.

Leather.—(1) Bales, bundles, cases. (2) Bales are properly bound with rope or stout twine. Leather from America is shipped in this form.

Lime (chloride).—Fault is here found with the common barrel in this trade. It should be more substantial.

Linens.—(1) Cases, bales, hampers. (2) Fine linens are put up in small parcels, with a sheet of white paper next them, and packages are wrapped in strong brown paper; these parcels are put together and inclosed in stout canvas or packing sheets, then all are inclosed in oilskin or waterproof paper and packed in a wooden case, which is either roped or bound with iron hoops. Sometimes no case is used, and the package in this state, covered with bagging and well bound, is called a bale. Coarser goods are packed in a similar way and put in bales, as a rule.

Linoleum.—(1) Rolls, cases. (2) The pieces are cut in lengths and rolled upon wooden rollers. The roll is then covered with canvas or Hessians and tied up, and the goods are shipped in this state. When the goods are of fine quality, the roll is frequently put into a case. It should be added that in rolling fine goods, thin tissue paper is sometimes placed upon the pattern side of the cloth, so as to prevent the colors from rubbing against the back in the process of rolling.

Lithographic stones.—Breakage is not uncommon, owing to weak cases. The wood protection should be as complete and solid as possible, without rendering the case unwieldy.

Machinery.—(1) Cases, crates, pieces. (2) The best practice in packing machinery—heavy or light—is to firmly fix every piece to the case, either by bolts going through the case, or by battens arranged inside to securely lock the various pieces in position. With heavy machinery, no loose material should be used in any case. The American, as well as the Scotch, packing of machinery in general has been on this plan, and is everywhere commended.

Maps.—Packed in cases lined with oilcloth.

Marble.—(1) Blocks, frames, cases. (2) The naked blocks of rough marble are usually well enough protected with straw on shipboard. The frames intended to protect the edges of polished shafts or blocks are frequently not as substantial as they should be, and injury results. Finished marble of much value should always be cased.

Meal (cotton seed).—Good bags are required in this trade. There has long been considerable waste due to the bags being of inferior material, or badly made of good material. This applies especially to American cotton-seed meal bags.

Meat (canned).—American cases are of first-class material, but occasionally show carelessness or haste in the packing house, being insufficiently nailed or bound together.

Millboard.—(1) Packages, bales, cases. (2) The packages or bundles are bound with stout twine.

Molasses.—For some years the barrels were of poor quality and gave much trouble. The iron-bound barrels now in use are uniformly good.

Moss litter.—(1) Bales, packs, bundles. (2) Bales well bound with wire.

Moldings.—(1) Cases, bundles. (2) Coarse grades have no covering and are simply bound with ropes, which are considered hardly adequate. The cases in which gilt moldings are brought from America could be improved, being rather frail.

Musical instruments.—These are uniformly well cased at present, in both the United States and Germany. The instruments are firmly fixed, and the edges and corners fully protected.

Nails.—(1) Bags, kegs, packages, boxes. (2) Of course, kegs are a better protection from dampness than bags, but bags are more easily handled and are almost universally used, not for this reason only, but for the more practical one of economy. Bags of nails for Great Britain should always contain 112 pounds each.

Netting (wire).—(1) Rolls, packs, bundles. (2) Mostly in moderate-sized rolls. It is important that these be firmly and smoothly fastened at the outer edge.

Nets (fishing).—(1) Bales, coils. (2) Each net is lapped up separately in the form of a web. From 4 to 6 of these webs are put into one press-packed bale, which is covered with oilcloth and then with Hessian wrapper.

Oats (Quaker).—It is thought that the cases would be improved by the use of a little stronger material.

Ocher.—Shippers are advised to always be careful to see that each barrel is well lined with paper, to prevent waste and also damage to other goods.

Oil cake.—(1) Bags, bulks, bales. (2) Nearly all kinds of oil cake are imported into this market in bulk, except from the United States. The bags used by our producers and exporters are substantial and satisfactory.

Oils (other than petroleum).—The casks generally used in this trade, from the United States and the Continent, are not regarded as up to requirements. There is a good deal of waste and consequent damage to other merchandise. The defect lies, I understand, not in bad workmanship in the construction of the casks or barrels, but in poor wood.

Paint.—(1) Cases, barrels, cans. (2) Principally in cans packed in cases. The matter of importance is to make the tops of the cans secure. This done, any ordinary case is sufficient.

Paper pulp.—(1) Bales, packages. (2) The best bales are bound with bagging and firmly wired.

Paper (rolls).—The paper covering ordinarily used affords ample protection, as a rule, against the weather and rough handling, but a tougher covering, either paper or some other material, would prevent much of the damage done to these rolls from cutting.

Paper stock.—Press-packed bales, covered with canvas and bound with iron hoops.

Paraffin scale.—Good barrels are necessary. At present there is much waste. There is no complaint as to the common barrels for paraffin wax.

Pavement (wood).—In packing on shipboard, it is well to provide a "stowing" of straw.

Petroleum.—Extra-strong barrels are required for this trade. As a rule, the barrels now used, both in America and Russia, are of this class.

Pig products (feet and heads).—(1) Barrels, tierces, cases. (2) Substantial, iron-bound barrels. These are the kind uniformly used by shippers in Denmark.

Plates (electrotyped and stereotyped).—In solid wood cases of suitable size. A single plate is rolled in paper, with the back of the plate against the wood. Then each two plates are packed back to back (rolled in paper), and at the end of the case another single plate, protected by paper, is put in.

Plants.—(1) Hampers, bales, barrels, baskets. (2) Whatever the form of package, an ample binding of the plant with straw is the essential thing. It is held that nothing serves the purpose of protection as well as straw.

Potash.—(1) Barrels, drums, kegs, cases. (2) All barrels and kegs should be well lined with paper.

Printed sheets.—These are generally packed flat and made into bundles, the bundles containing varying numbers of copies, according to the size of the book. In some instances the sheets are folded, and when this is done each copy is, as a rule, done up in a sheet of the printed paper, so as to avoid confusion. The bales of printed sheets are packed in the usual export cases without zinc lining.

Rags.—Bales are press-packed and hooped with iron.

Rice.—(1) Bags, barrels, cases. (2) The vast bulk is in bags of good quality, as the trade requires. Finer bags are necessary, of course, for rice meal, and they are not always provided, and as a consequence there is a good deal of loss from leakage.

Rope.—(1) Coils, bales, bundles. (2) Coils and bales are properly covered with a sacking wrapper.

Rosin.—Barrels of only the ordinary strength are needed. Some of those coming from the United States are rather frail, and there is considerable loss.

Seed.—(1) Bulk, bags, bales. (2) While cotton seed and linseed are bulk articles (though Russia ships the latter in bags to some extent) the finer seeds, like clover, must be in the finest cotton or cotton-linen bags to prevent loss by leakage. On the part of some shippers, there is an apparent disposition to risk much in this matter.

Shells.—Bags of crushed shells (for poultry) come to this port in bad condition, now and then. The bags are of poor quality. Some of them are from United States shippers.

Starch.—(1) Cases, bags, packages, barrels. (2) Mostly in bags from the United States, received in good condition.

Straw.—Press-packed bales, bound with wire.

Sugar.—(1) Bags, cases, barrels. (2) Nearly all sugar is in bags of substantial quality and perhaps the minimum loss is sustained by the trade.

Sugar candy.—(1) Boxes, packages, bags. (2) Too many of the boxes or cases at present are frail, and damage is frequent.

Thread.—Made up in suitable parcels and packed in cases lined with waterproof paper.

Timber.—Largely in a rough state. There is in this part of Scotland a growing trade in dressed wood of all kinds from the United States, shipped in bundles; the pieces should be kept as nearly as possible all of one size in each bundle, and more securely bound than at present.

Tobacco.—(1) Hogsheads, tierces, cases. (2) There must be special care to make firm the heads of hogsheads. It is said at this port that indifferent work in "heading up" gives practically all the trouble experienced in handling tobacco.

Tools.—In cardboard boxes, packed in strong cases of convenient size bound with hoop iron.

Tubes.—(1) Bundles, cases, pieces. (2) At most European ports there is a decided objection to heavy bundles of iron or steel or other metal. Care should be exercised in packing, to keep the bundles a moderate weight.

Turpentine.—Extra care is suggested as necessary in heading up barrels intended for turpentine.

Twine.—(1) Cases, bales. (2) The practice is to make up half-pound balls in parcels of 25 or 30 pounds, and pack in cases containing not more than 500 pounds, lined with waterproof paper.

Varnish.—(1) Barrels, cases. (2) Both barrels and cases must be well made and rather heavy in material. Continental barrels are sometimes too light and weak.

Vegetables.—(1) Bags, bales, hogsheads, barrels, baskets, hampers, boxes, cases. (2) Principally in bags and baskets, according to the nature of the goods. Bags, baskets, and other packages from Egypt are not as strong and satisfactory as those from Spain. Potatoes are well put up in Malta and arrive in good condition. Little complaint is made as to the packing of vegetables from the United States; but the Spanish exporters probably are most successful in this respect.

Vinegar.—(1) Barrels, cases. (2) The statement as to turpentine barrels (see above) applies to those used for vinegar. Not a few barrels are defective in the heads, and the loss from leakage at this port is considerable.

Vulcanite and celluloid goods.—Small goods are usually packed 1 dozen in a box, or else on cards; each box is wrapped in oil paper, or a thin paper of good quality, and then cased.

Washboards.—Bundles bound with wood "lining," or broad strips, are considered proper packages, and there is seldom any serious loss from breakage or other damage.

Wheels.—(1) Crates, cases. (2) The American packing is regarded as excellent, the wood protection being as complete and substantial as could be desired.

Whisky.—(1) Cases, barrels. (2) Usually in cases of 12 bottles, called reputed quarts, capacity 6 to the gallon. The bottles (after being labeled and capsuled) are packed each in a thick straw envelope and these placed heads and tails on their sides in the case in two rows of 6 each, the cases being of such dimensions that with the "spring" in the straw the contents fit very tightly when the lid is nailed down. Some shippers pack in binned cases, lined with corrugated paper and filled up with straw. Iron-hooped oak barrels are used for bulk whisky. Barrels made of American oak staves are regarded as the best.

Wire.—(1) Reels, bundles. (2) The obvious requirement is to perfectly secure the ends of the wire. Yet this is not always done.

Wood pulp.—Bales should be in gunny bags, or wrapped tightly in sheets of the pulp, and tied so firmly that the cord or twine will not be removed or loosened by the most careless handling. Much fault has been found with the packing of wood pulp received from the United States and Canada. Not only is it, as a rule, without the covering of bagging used by Norwegian shippers, but the tying up is poorly done and there is nearly always loss through the breaking of the frail binding of twine.

Wood ware.—(1) Bundles, cases, bales, bags. (2) From the United States this ware is chiefly in cases at the present time, and that is the most satisfactory way to send these articles. The trade highly appreciates the kind of packing that brings goods in first-rate condition.

Woolens.—(1) Cases, packages, bales. (2) In packing separate lots of various sizes, the method here regarded as best is this: The lengths of cloth are rolled on boards, which are then withdrawn, and several lengths are put together in paper and tied up with twine. The parcels are then packed in a strong wooden case, lined with oilcloth, and hooped with iron bands. In packing large quantities, each roll is wrapped in thin oilcloth.

Increased Tariff in Costa Rica.—Minister Merry writes from San José, May 4, 1901:

The government of Costa Rica has issued a decree increasing the duties on all importations into the republic after April 28, 1901, 50 per cent. The announcement is accompanied with the suggestion that, as an offset to this additional duty, it will be the policy of the government to reduce the export tax on coffee. The importation of foreign products during the last half of the year 1900 has been comparatively heavy, and while the revenue may not at first be greatly increased by the decree it will induce an economy among the people which should be an advantage to the country. Costa Rica needs, above all things, a diversity of production which will decrease her dependence upon any leading article. While this necessity is generally recognized, little progress has thus far been made in this direction, although the abundant natural resources of the country admit of many other valuable products, among them cacao, india rubber, textile fibers, tropical fruits, etc. The banana industry is being rapidly developed and also the planting of india-rubber trees, the latter, however, requiring six to eight years before profitable results can be expected.

Zinc Poison in Colored Hosiery.—Consul Hughes, of Coburg, April 23, 1901, says that the bad effects of wearing pearl-gray silk hosiery, colored by repeated baths in a solution of zinc chloride, has been demonstrated by Dr. Adolph Jolles before the Vienna Medical Society. Dr. Jolles, adds the consul, showed conclusively that as much as 25 per cent of the zinc coloring matter was still on the hosiery when it was packed for market, and that the danger from absorbing this poison through the pores of the skin was very great.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

ACETYLENE IN SOLUTION.

As well known, acetylene in burning gives a flame that is much more luminous than that of coal gas. On another hand, the discovery of calcium carbide by M. Moissan has permitted of obtaining this gas at a very low figure. It suffices to cause water to react upon the carbide in order to obtain an abundant disengagement of acetylene; but, unfortunately, the manipulation is dangerous, and numerous accidents have given a bad reputation to lighting with this agent. Such accidents have almost always been caused by an excessive production of the gas, which, with the atmospheric air, forms an eminently explosive mixture. Moreover, acetylene is an "endothermic" compound; that is to say, it is apt, under certain circumstances, to decompose with a disengagement of heat. Hence it follows that such decomposition is accompanied with a great increase in volume or a great increase in pressure. Acetylene is, in fact, an explosive body. This fact is of a nature to render the accumulation of the gas under a slight pressure very dangerous.

Nevertheless, there now exist numerous apparatus that permit of regulating the production of acetylene and of burning it in perfect safety. In certain localities where there is neither gas nor electricity, there have been established lighting installations that are operating in an absolutely satisfactory manner; but these are stationary and have to be submitted to a regular surveillance, which, however, is rendered easy by the fixed character of the apparatus.

An interesting problem to be solved was that of rendering acetylene portable. In the first place, an endeavor was made to compress it at a high pressure, or even to liquefy it (since it easily liquefied in very strong receptacles); but such processes had to be abandoned on account of dangers of explosion that the endothermic properties of acetylene always rendered imminent. In 1896 MM. Claude and Hess, two French engineers, conceived the idea of utilizing for the same object a solution of acetylene in an appropriate liquid, and, after some researches, selected acetone as the solvent. Acetone, which is comparatively cheap and not very volatile, boils at 56 deg. C. and does not freeze. The quantity of acetylene that it is capable of dissolving is 24 volumes per atmosphere at a temperature of 15 deg. C. Thus, a quart of acetone at a medium pressure of 10 atmospheres dissolves 8.5 cubic feet of acetylene, while its volume increases by about 13.6 fluid ounces. This solution presents the remarkable property of being inexplosive, as has been shown by MM. Berthelot and Vieille. If, into a vessel containing acetylene dissolved under a pressure of 10 atmospheres, we insert a wire heated to redness, or if a percussion cap be made to explode in the vessel, all that will occur will be an explosion of the small quantity of gas that exists above the solution, without the latter being influenced in the least; while if the vessel were filled with liquefied gas there would occur a formidable explosion capable of developing pressures of from 5,000 to 6,000 atmospheres.

It results from the experiments of the two above named chemists that the stability of the solution is maintained up to the neighborhood of a pressure of 20 atmospheres. So the use of this solution presents a remarkable character of safety, since nothing but an explosion of the small quantity of gas that exists above the liquid in the receptacle need ever be feared.

Nevertheless, as slight as is the danger of this small explosion, it is yet incompatible with the exigencies of practice, which demands absolute safety. Moreover, in certain applications, such, for example, as the lighting of public carriages, the presence of a mass of an eminently combustible liquid capable, in case of accident, of spreading in flames outside of its receptacle is entirely inadmissible. Finally, the solution of acetylene in acetone takes place but slowly, and, inversely, the disengagement of the gas is quite irregular because of very marked phenomena of supersaturation.

New studies, therefore, became necessary, and these were undertaken by the Compagnie Française de l'Acetylene Dissous. This company has finally succeeded in devising the necessary apparatus and in rendering the ingenious idea of the first inventors truly practical and industrial. Such a result is obtained by the use of "porous materials." After several tentatives the company has succeeded in producing a ceramic material—a peculiar porous brick of a specific weight of 0.5, which possesses extremely fine pores. The receptacle is exactly filled with this substance, and then the liquid and afterward the gas under pressure is introduced. The liquid, retained by capillarity, can no longer escape, even though the vessel containing it should get broken.

The duration of the process of solution is considerably abridged, and the discharge at the moment of decompression is rendered perfectly regular, since all the phenomena of supersaturation are suppressed. Finally, and this is the important point, there exists no empty space in the apparatus, other than the pores of the brick, and all dangers of an explosion, however slight it may be, are absolutely prevented. We know, in fact, that an explosive wave cannot propagate

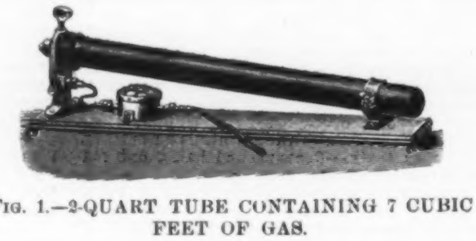


FIG. 1.—2-QUART TUBE CONTAINING 7 CUBIC FEET OF GAS.

itself through very fine tubes; and it is still less capable of transmitting itself through the pores of the brick. So, even though the liquid should not entirely fill the pores and should leave a space for free gas, the latter would not in any manner explode. The experiments that have been made on this subject have even shown that it would be possible, without any danger, much to exceed the pressure starting from which the free solution ceases to be perfectly stable. At 25 atmospheres, for example, the free solution is an explosive liquid, while this same solution incorporated in the porous brick constitutes, under the same pressure, an absolutely inert body. Such high pressures as these, however, are never employed in the industries. The utilization of the gas coming from the receptacle requires a few simple precautions. It is necessary to bring the pressure of 10 atmospheres to that of a few inches of water. This is the rôle of the expander. There is a mercurial safety valve, too, for permitting the gas to escape in cases in which, in consequence of damage, the pressure might tend to rise beyond measure in the pipes. Finally the gas passes through a meter of the dry type, and a pressure gage that communicates with the receptacle permits, through the lowering of the pressure, of recognizing the moment at which the receptacle is about to become empty, and at which it is necessary to replace it. As all these apparatus are unaffected by frost, they can be placed out of doors, and this further adds to the safety.

The types of receptacles most usually employed are: 1. A 2-quart tube of an internal diameter of 2.5 inches and of a length of 30. It contains 7 cubic feet of dissolved gas and is mounted upon a board carrying the accessory apparatus—the expander and pressure gage, both placed in a copper box (Fig. 1). This apparatus is used for exceptional lightings of short duration, and is capable of furnishing a 100 candle power light for two hours and a half, or one of 50 candle power for five hours. It is particularly adapted for the lighting of projection lamps. If the gas is burned in a burner provided with an incandescent mantle, there is obtained a luminous intensity greater than that of the oxyhydrogen light, and which is surpassed only by that of the voltaic arc. By means of an appropriate mounting, the same tube may be used as an acetylene torch for carriage upon the shoulder or for being planted in the ground. This apparatus is very advantageous for the lighting of automobile carriages. Two of the tubes suffice to assure a light for thirteen or fourteen hours, with a fully adequate consumption of 1 cubic foot an hour.

2. An 11-quart tube 6 inches in diameter and 42 inches long. This receptacle, which contains 42 cubic feet of gas, is applied to the lighting of street railway cars. Upon the Belleville line such a tube supplies the two lamps of a car for four or five hours without being renewed. This tube, in connection with a powerful reflector, was used also for the lighting of the Bois de Vincennes during the Exposition of 1900 (Fig. 2). It is capable of furnishing a light of 150 candle power for 10 hours, and, through the use of incandescence, gives the elevated figure of 500 candles.

3. A 23-gallon receptacle formed of a tube 16 inches in diameter and 36 in length entirely enveloped by staves, which renders the manipulation easy and protects the receptacle against shocks and the heat of the sun (Fig. 3). This apparatus contains 350 cubic meters of acetylene and stores up 13,000 candle-hours. It is adapted for stationary installations.

4. A wagon of 35 cubic feet carrying four large cylindrical reservoirs 24 inches in diameter and 6.5 feet in length, each having a capacity of 225 quarts (Fig. 4). It contains 3,500 cubic feet of acetylene capable of furnishing 3,000 candle power for fifty hours, or of supplying 1,000 30-candle burners for five hours. In default of extensive gas and electric mains, such a lighting could be obtained by no other process than by the aid of large and costly installations. This wagon has already been used for the illumination of fêtes and the lighting of country theaters.—For the above information and the engravings we are indebted to La Nature.

FIG. 2.—11-QUART TUBE CONTAINING 42 CUBIC FEET OF GAS DISSOLVED IN ACETONE.

FIG. 3.—23-GALLON CASK CONTAINING 350 CUBIC METERS OF ACETYLENE DISSOLVED IN ACETONE.

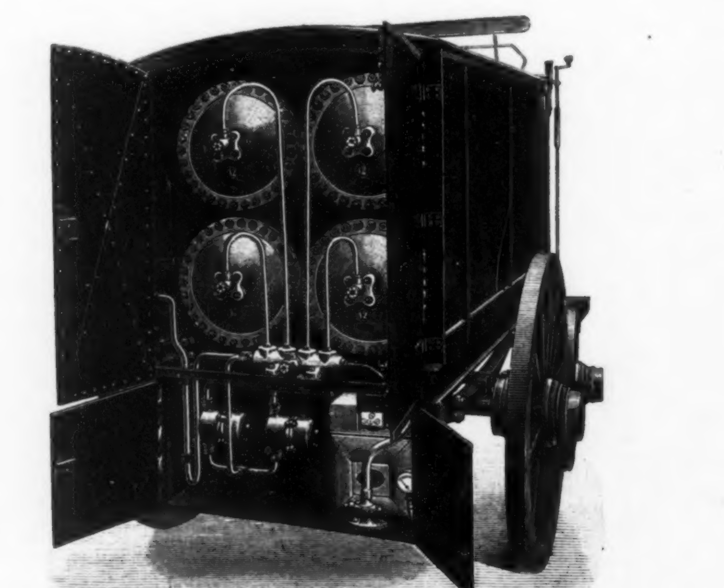


FIG. 4.—A WAGON OF 35 CUBIC FEET CONTAINING 3,500 CUBIC FEET OF ACETYLENE DISSOLVED IN ACETONE.

PROCESS FOR THE TREATMENT OF SULPHURETED ORES AND MINING PRODUCTS IN THE ELECTRIC FURNACE.

By M. DIEFFENBACH.

IN this process, heating the ores in the electric furnace is recommended as an important feature. Various inconveniences are thus avoided. With the elevated temperature secured by this furnace, a very liquid scum is formed, even in the presence of a great excess of coal, while the zinc vapors are simply mixed with carbon oxide, with variable quantities of sulphurous acid.

With the electric furnace, ferric oxide can be replaced by other oxidizing substances with the same success. If, for example, blende is mixed with lime and coal, calcium sulphite is obtained in the state of liquid scoria, while the zinc is distilled. A similar result follows the employment of alumina, magnesia, silica, and other oxidants. Many natural rocks, as felspar, can be substituted.

If the blende contains many oxygenized compounds some other addition than coal may be needful for setting the zinc at liberty.

If an ore of oxidized zinc is added to the blende both are reduced at the same time in the furnace. If the blende is heated with such products as mentioned above, without the coal, or if this contains suitable gangue, a conversion to zinc oxide takes place under the influence of oxygenized combinations. After the separation of the scoria by metallurgic, chemical, or electro-chemical processes, the zinc oxide may be treated for obtaining metallic zinc or zinc-bearing derivatives.

In certain cases the scoriæ may be rendered useful. Thus, those contaning ferric sulphide may serve for the preparation of sulphurous acid or of ferric sulphate; those which contain calcium sulphite may serve for the preparation of hyposulphites.

This treatment of blende is applicable equally to sulphureted ores or to mixtures of ores.

The type of the electric furnace may vary. The fusion may be effected by the arc itself, or by heating with resistance, whether the matter to be decomposed itself constitutes the resistance or whether a special resistance is intercalated. In fact, recourse can be had to any mode of heating.—Translated from La Revue des Produits Chimiques.

KINGSLAND'S SURFACE CONTACT SYSTEM.

WE illustrate an interesting system of electric traction on the surface contact system, of which a demonstration was given at Wolverhampton recently by the Kingsland Surface Contact Syndicate, of Breams Buildings, Chancery Lane, W. C. In all surface contact traction systems, the current is collected by a skate fixed below the car which slides over metal studs inserted in the roadway between the rails, and projecting some ½ inch to ¾ inch above the general level of the pavement. As the supply of current is taken at some 500 volts, it is obvious that if these studs were maintained constantly charged they would be a serious menace to horses, to say nothing of pedestrians using the roadway. Means have, therefore, to be provided by which only those studs are charged which are actually under the skate, and, as the car moves, it must cut out the studs it leaves behind it, while cutting in, one by one, those in advance as it approaches them. This has hitherto been generally effected by electromagnetic switches of some description or other; and the special feature of the Kingsland system is to be found in the fact that the commutators are operated entirely by mechanical means. This has involved the use of a conduit, but this conduit is only rail-height in depth, and but 3 inches or 4 inches across at the widest part. At short intervals along this conduit a starwheel projects into it, and this wheel is turned through the space of one tooth as the car reaches it by a striker fixed to the car. A second striker at the back of the car turns the star through a second tooth as the car leaves. Thus every time a car passes a starwheel the latter is moved through two teeth. The starwheel being connected to a commutator, the latter is moved through one-sixth of a turn by the action of the first striker, and through a second sixth by that of the second striker. The first motion switches into circuit with the feeder the stud which the skate has at that moment reached, and the second motion cuts it out again as the skate moves on, leaving the stud dead.

The general arrangement of the track and commutator system is very clearly shown in Fig. 1. The conduit is at the right, with the starwheel projecting into it. The track box is shown in Figs. 2 and 3, and is of cast iron. The boxes are spaced at intervals of 18 feet or more, and they weigh each about 1 cwt. The starwheel, *L*, is carried on a bracket, *B*, fixed to the side of the box, which, it will be seen, extends well under the rail and conduit. Inside this box is a second box, *H*, which makes a watertight joint with the main box at *J*, and serves to support the commutator shaft, *A*. The connection between this shaft and the starwheel shaft, *C*, is effected by means of an Oldham coupling, which not only avoids the necessity of an exact alignment between the centers of these shafts, but also permits of the box, *H*, being removed bodily without affecting the starwheel, *L*. The box, *H*, is held in place merely by a couple of bolts, one of which is clearly shown in Fig. 3, and these are accessible through the cover, *F*. The connection to the main is led in at the bottom of the box, *H*, the cable, *M*, terminating in a split contact pin, *P*. A second and similar pin connects the box to the road stud through the cable, *N*. The commutator, *W*, has three segments, and there are two brushes, *T* and *T'*, connected respectively to the stud and the feeder pins. These brushes are placed in reference to the commutator, *W*, at an angle of 120° with each other. Hence, when one brush rests on a segment, so does the other, and the stud is then connected to the main. One-sixth of a turn of the commutator, however, brings both brushes on to the insulation, and the stud is then dead.

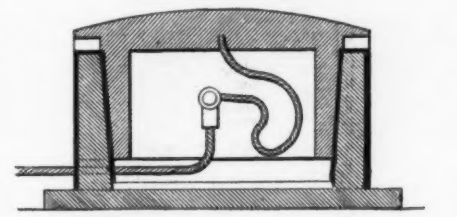


FIG. 5.

In order that the device may work satisfactorily, it is essential that over-running shall be prevented, and this is accomplished by means of a peculiar screw ratchet arrangement fitted at the back of the commutator and shown at *K*. The commutator shaft bears at its end an interrupted screw somewhat like that used for the breech-locks of ordnance; but while in the latter each screwed segment is in line with that following and that preceding it, so that a nut can be screwed over the block just as if the thread were continuous, this is not the case in the present instance, since the threads of each screwed segment are half a pitch in advance of those of the preceding segment. As a consequence, if a nut were moved through one-sixth of a turn, it would be brought up against the face of the threads of the next segment, and could not be turned through another one-sixth turn until it had been slid along the bolt for the distance of half a pitch. In the present case this longitudinal traverse is accomplished by means of springs. This device prevents the starwheel overrunning most effectually, and has been tested up to car speeds of 20 miles per hour. In actual practice a double screw ratchet is used, one coming into operation when the car is moving forward, and the other when it is reversed.

A diagrammatic sketch of the track studs and commutators is given in Fig. 4. In this the studs are represented by S_1, S_2, and S_3, while the commutators are marked *C*. As shown, all the studs are dead, but one-sixth of a turn of any commutator will establish an electrical connection between the brush, *a* and *b*, and thus between the corresponding stud and the main, *M*. A section through one of the studs is shown in Fig. 5. It is made of cast iron, and measures on top some 12 inches long by about 3½ inches to 4 inches wide.—For our engravings we are indebted to Engineering and The Engineer.

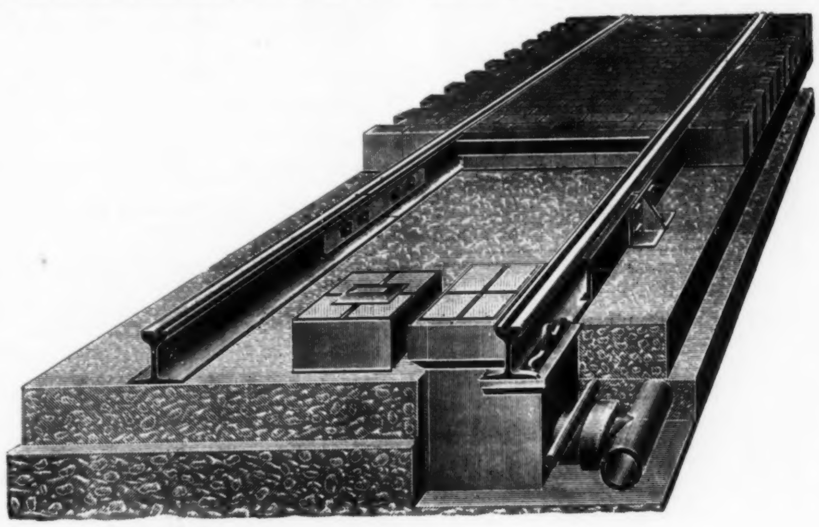
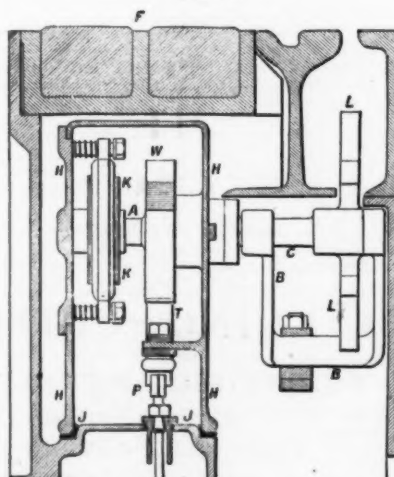
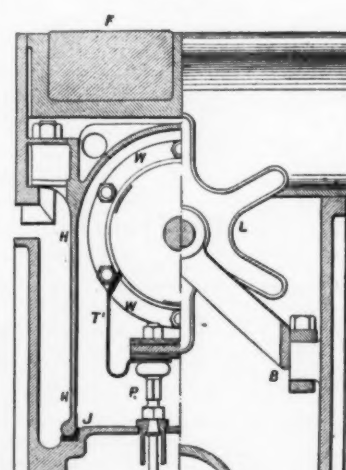


FIG. 2. FIG. 1. FIG. 3.





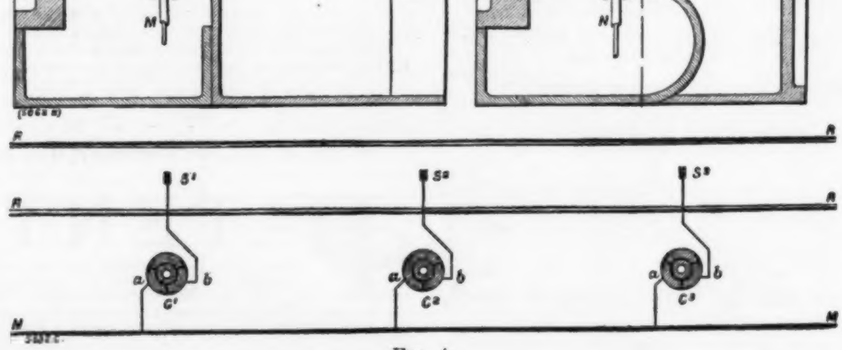


FIG. 4.

KINGSLAND'S SURFACE CONTACT SYSTEM.

CONTEMPORARY ELECTRICAL SCIENCE.*

INFLUENCE OF TEMPERATURE UPON BECQUEREL RAYS.—E. Rutherford has shown that thorium compounds continually send out a kind of radio-active particles which retain their power of ionizing air for several minutes. These particles are capable of penetrating solutions and cotton wool stoppers without losing their efficacy. The same author has now investigated the effect of heating the thorium compounds. Red heat increased the radio-activity to about three times its original value. White heat destroyed it almost completely, and cooling the specimen led to no recovery. If the temperature never exceeded a red heat, the preparation would return to its normal activity on cooling, but a bright red heat considerably retarded the process. The behavior of radium preparations was very much more remarkable. A bright red heat would increase the radio-activity 5,000 times. Further heating had no effect, and seemed, indeed, to interfere with or partly destroy the radio-activity at the lower temperatures. The author inclines to the conclusion that the radio-activity is due to some chemical process within the material. Dorn's observation, that the radio-activity is increased by moisture, confirms this supposition.—E. Rutherford, Phys. Zeitschr., April 20, 1901.

ABNORMAL IONIC VELOCITIES.—The greater velocity of the negative ions over the positive ones has been so generally recognized that the discovery of the reverse case is of special interest. C. D. Child has shown that, in order to account for the fall of potential through the arc, it is necessary to assume that the positive ions move more rapidly than the negative ones. He has, therefore, attempted to demonstrate this by experiment, and although he is not able to bring any direct evidence with regard to the state of things within the arc itself, he is able to prove, by a study of the rate of discharge from an arc to a neighboring body, that under varying conditions as to difference of potential, distance, and current in the arc itself the positive ions drawn out from the arc move more rapidly than the negative ones. This is not to be explained as an effect due to ultra-violet light or any phenomena previously studied. The positive ions from a carbon placed in an oxy-hydrogen flame also move the more rapidly. In cases of an arc between metals, the negative ions move the more rapidly. The author believes that the positive ions move more rapidly within the arc itself, and that this curious phenomenon is somehow connected with the high temperature and the nature of carbon.—C. D. Child, Phys. Review, March, 1901.

PHOSPHORESCENT GLOW IN GASES.—An exhaustive study of the electrodeless ring discharge first described by J. J. Thompson has been made by J. B. B. Burke. It will be remembered that the glows can be produced by discharging a Leyden jar through a few turns of wire wound round a vacuum bulb. The author shows that the glow is not confined to the surface of the glass, but is a true volume effect. It is of unelectrified particles. It is not the result of the re-combination of ions liberated by the spark, as these ions in long tubes will travel away from the glow. An E.M.F. has no effect upon the glow, but the latter conducts as it passes through the gas. The destructive effect of sparks upon the glow is due to cathode rays or fast-moving negative ions. The glow is due to impurities, but oxygen is a necessary element, and most probably ozone also; but these are not sufficient by themselves. The glowing particles appear to be large molecular groups formed by the spark, whose existence may be maintained for some time, notwithstanding the bombardment from the other molecules, since they exert a repulsion on the latter. The glowing particles show several points of resemblance to thorium rays.—J. B. B. Burke, Phil. Mag., March and April, 1901.

COHERER ACTION.—K. E. Guthe has made a somewhat novel experiment to study the real nature of coherer action. Two fine wires of the same metal were mounted at right angles to each other and brought into contact. A current was then sent through one of the

* Compiled by E. E. Fournier d'Albe, in the Electrician.

wires, so as to heat the contact. During the heating a current was sent from one wire to the other. It was found that under otherwise equal conditions the resistance of the contact was the smaller the hotter the contact, and that the resistance returned to its original value on stopping the heating. The author believes that the first stage of the coherer effect consists in the heating of the junctions between neighboring particles. But another process must take place as well, since the coherer does not recover its original resistance at once, whereas the wire junction does. If the coherer consists of mixed metals, and bismuth is one of them, the junction between bismuth and the other metal is heated rapidly, since bismuth is a very bad conductor of heat. This effect may sometimes be marked by a Peltier effect, since the heating of the junction between the bismuth and the other metal may give rise to a current opposed to the main current traversing the coherer.—K. E. Guthe, Ann. der Physik, No. 4, 1901.

ALUMINIUM AS AN ELECTRODE.—A. Bartorelli has continued his researches on the electrode properties of aluminium, with special reference to their use as "valves" for rectifying alternate currents. The fact that the transition resistance of the electrode as an anode is inversely proportional to the sectional area of the electrode shows that the resistance is confined to the contact surface between metal and liquid. The resistance decreases gradually as the density of the current increases, and this the author attributes to some transformation of the non-conducting layer which may be of either a physical or a chemical nature. As regards the question whether the one-sided resistance of an aluminium anode is due to true resistance or polarization, the author believes that for small E.M.F.'s we have a true resistance effect, and for large E.M.F.'s a polarization effect.—A. Bartorelli, Phys. Zeitschr., May 11, 1901.

LONGITUDINAL THERMO-MAGNETIC EFFECT.—Let a circuit consist partly of bismuth and partly of other metals. Let the latter be traversed by a current of heat in a certain direction, and let it be immersed in a magnetic field whose lines of force are at right angles to the heat current. Then the E.M.F. of the circuit depends upon the strength of the magnetic field. This effect was discovered by Ettinghausen and Nernst in the year 1886. L. Lownds has devoted some work to discovering in what way the effect depends upon the strength of the magnetic field. He finds that when one junction is kept at a temperature of —120 deg., the effect attains a maximum at a field intensity of 2,450 units, and then decreases with increasing field, probably becoming negative at a certain strength. This is remarkable in the face of Yamaguchi's result that the transverse thermo-magnetic effect continues to increase with the field, even at the lowest temperatures attained. Both the longitudinal effect and the change of resistance may be represented by the same formula, except at low temperatures, where the longitudinal effect changes sign.—L. Lownds, Ann. der Physik, No. 4, 1901.

INDUCTION IN AN OPEN CIRCUIT.—J. Koenigsberger reports the results of some experiments made to demonstrate, if possible, the existence of the displacement current induced in a circuit consisting partly or wholly of dielectric material when either the conducting or the non-conducting part of it is placed in a varying magnetic field. For the first case a solenoid of 2,040 turns of fine copper wire was brought between the poles of a strong electromagnet. One of the ends of the solenoid was put to earth, while the other was connected with one pair of quadrants of a Thomson electrometer. On exciting the magnet a deflection was observed corresponding to a potential integral of 4.7 volts. It appears that this induced potential is directly proportional to the field intensity, and to the number and sectional area of the coils. This gives, incidentally, a new means of measuring magnetic fields. The potential is independent of the capacity and resistance of the open circuit. The experiments in connection with the other alternative are of much greater difficulty. If in two paraffin rings the dielectric polarization were to change rapidly in a tangential direction, those rings would attract each other like two conducting circuits. The great mass necessary for a crucial test at present excludes an actual experiment, but results could be hoped for from an ordinary open circuit containing a small portion of dielectric immersed in a magnetic field. The author has not had an opportunity of making the test. The effect would be very small in any case. The author points out that if a vacuum is traversed by a displacement current, a finite amount of work must be performed, or otherwise no induction effect of finite electromagnetic energy can take place. The latter alternative is the more probable, since a ray of light in air is not influenced by a change of the magnetic field.—J. Koenigsberger, Phys. Zeitschr., May 11, 1901.

PHOTOGRAPHONE.—Among the various methods of registering sound vibrations those based upon photography are the most sensitive and accurate; but, though good photographic records have been obtained both from the ordinary phonograph cylinder and from sensitive flames, no method of reproducing the sounds from the photographic record has hitherto been devised. E. Ruhmer has now, however, hit upon a method of reproducing them which is distinctly ingenious and novel, and opens up a new vista of possibilities. He photographs a "speaking arc" or other sensitive flame on a moving film, and reproduces the sound by projecting light through the film on to a selenium cell in circuit with a battery and telephone. Every variation of the light impinging upon the selenium cell produces a sound in the telephone, and the reproduction is superior in sensitiveness and clearness to the Poulsen telegraphone. Moreover, the film can be made of very considerable length without losing its lightness and portability, which cannot be said of either the wax cylinder or the telegraphone wire. Another great advantage is that any number of prints of equal value can be taken off the same negative. A print kindly sent by the author shows 13 clear maxima of luminosity. Cylindrical lenses are used for concentrating the light upon the film. The author is at work improving the speaking flame.—E. Ruhmer, Der Mechaniker, No. 7, 1901.

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